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| May 2022 | |

[www.africa-rising.net](http://www.africa-rising.net)

Africa RISING

ESA Project 2021-2022 Workplan

The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development as part of the U.S. government’s Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program’s monitoring, evaluation and impact assessment. <http://africa-rising.net/>

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**Contents**

[Partners and their responsibilities 2](#_Toc53124431)

[Summary 4](#_Toc53124432)

[Background Error! Bookmark not defined.](#_Toc53124433)

[Project logframe overview 1](#_Toc53124434)

[Planned work 1](#_Toc53124435)

[Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability 1](#_Toc53124436)

[Outcome 2: Natural resource integrity and resilience to climate change enhanced for the target communities and agro-ecologies Error! Bookmark not defined.](#_Toc53124437)

[Outcome 3: Food and feed safety, nutritional quality, and income security of target smallholder families improved equitably (within households) Error! Bookmark not defined.](#_Toc53124438)

[Outcome 4: Functionality of input and output markets and other institutions to deliver demand-driven sustainable intensification research products improved Error! Bookmark not defined.](#_Toc53124439)

[Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized Error! Bookmark not defined.](#_Toc53124440)

[Consolidated ESA project budget 67](#_Toc53124441)

[Feed the Future and Custom Indicators Error! Bookmark not defined.](#_Toc53124442)

# Partners and their responsibilities

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Acronym** | **Role/responsibility** | |
| **Government Ministries & Entities** | | | |
| District Government Authorities |  | Facilitating (farmer) contacts, supervising field activities & scaling | |
| Machinga District Council Agriculture Development Division | Machinga ADD | Taking technologies to scale | |
| **National Academic and National Research Institutions** | | | |
| Tanzania Agricultural Research Institute | TARI | Research and scaling with its Centres Selian, Naliendele, Hombolo, and, Dakawa | |
| Zambia Agriculture Research Institute | ZARI | Research and scaling with Msekera Research Institute | |
| Sokoine University of Agriculture | SUA | Research and technology delivery; graduate student training | |
| University of Dodoma | UDOM | Research and technology delivery; graduate student training | |
| Kenyatta University |  | Ph.D. student | |
| University of Zimbabwe |  | MSc Students | |
| University of Amsterdam | UvA | MSc student | |
| Lilongwe University of Agriculture and Natural Resources | LUANAR | Implementing research and scaling; graduate student training | |
| **International Research Institutions and Universities** | | | |
| International Institute of Tropical Agriculture | IITA | Project Management, research, and technology delivery; student mentoring | |
| International Center for Tropical Agriculture | CIAT | Research and technology delivery; student mentoring | |
| International Crops Research Institute for the Semi-Arid Tropics | ICRISAT | Research and technology delivery; student mentoring | |
| International Food Policy Research Institute | IFPRI | Monitoring & Evaluation and research | |
| International Maize and Wheat Improvement Centre | CIMMYT | Research and technology delivery; student mentoring | |
| World Vegetable Centre | WorldVeg | Research and technology delivery; student mentoring | |
| World Agroforestry Centre | ICRAF | Research and technology delivery; student mentoring | |
| Michigan State University | MSU | Research and technology delivery; student mentoring | |
| Wageningen University and Research Centre | WUR | Research and technology delivery; student mentoring | |
| **Non-government and private organizations and development projects** | | | |
| Dodoma Agricultural Seed Producers’ Association | DASPA | | Development partner assisting in taking technologies to scale |
| Iles de Paix (Islands of Peace) | IDP | | A consortium of private and public development partners for taking technologies to scale |
| Total Land Care | TLC | | Taking technologies to scale |
| Leadership formation, Environmental Conservation & Action for Development Foundation | LEAD | | Promote best principles and practices of leadership, environmental conservation, and community development |
| Research Community and Development Association | RECODA | | Scaling partner |
| National Farmers’ Organization Tanzania | MVIWATA | | Scaling partner |
| ESOKO | ESOKO | | Scaling partner sending SMS to smallholder farmers |

# Summary

The Africa RISING East and Southern Africa (ESA) project is implemented by multi-disciplinary research teams and development partners from the public and private sectors in collaboration with farmers and community-based organizations in Tanzania and Malawi. This document presents the workplan for the 2021-2022 research year for ESA mapped under the five Outcomes in the Phase 2 project log frame as reflected in Table 2. Thirty sub-activity workplans are presented – seven for Outcome 1, three for Outcome 2, three for Outcome 3, three for Outcome 4, and fourteen for Outcome 5. The reduction in the number of sub-activities compared to last year is because several were completed and results documented, mainly as published manuscripts, but also as scaling communication outputs. An overview of broad categories of technologies validated to different SIAF (Sustainable Intensification Assessment Framework) domain levels is presented in Table 1, with details published as a handbook that may be accessed at <https://www.cabi.org/cabebooks/ebook/20220167029>

**Table 1:** Broad categories of validated flagship technologies during the past Africa RISING action years

|  |  |
| --- | --- |
| **Broad category** | **Validated flagship technologies** |
| Genetic integration involving introducing new crops and varieties to overcome existing biotic and abiotic stress | Drought-tolerant maize |
| Climbing bean; nutrient-dense beans |
| Stress resistant, high productive groundnut |
| Short-duration pigeon pea |
| Manipulation of crop ecologies to get more crops on limited land and maximize biological nitrogen fixation | Doubled-up food legumes |
| Doubled-up food legumes – mbili mbili spacing |
| Cereal-legume fodder intercropping |
| Grain legume–cereal intercropping and rotations |
| Farm-design crop sequencing |
| Integrated soil fertility management as a cost-effective approach to replenish soil fertility | Optimized fertilizer rates, composts |
| Livestock manure and fertilizer combinations |
| Cover crop composts |
| Introduction of land management technologies to reduce soil loss and enhance water utilization | In situ water harvesting |
| Physical barriers to reduce erosion – ‘fanya juu’, ‘fanya chini’, and shelterbelt |
| Cover crops |
| Conservation agriculture |
| Improved livestock feed quality and quantity | Quality forage and fodder-based feed rations |
| Poultry feeds with vegetable rations and housing |
| Livestock feed with fodder rations |
| Pre- and post-harvest approaches to reduce food waste and improve food safety | Motorized shelling machines, collapsible dryer cases, PICS bags |
| Aflasafe application in maize and groundnut fields |
| Nutrient-rich food crops and improved household nutrition | Recipes for improved child and household nutrition |
| Vegetables |
| Quality protein maize |
| Nutrient fortified beans |
| Orange-fleshed sweet potato |

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# Project logframe overview

An overview of the Africa RISING East and Southern Africa Project logframe up to the sub-activity level for the year 2021-2022 can be glanced at in Table 2 below. All sub-activities initiated by project partners align with specific outcomes, outputs, and activities within the logframe. For a detailed look at other important logframe elements like objectively verifiable indicators, sources, and means of verification, the assumptions for each output, etc. The complete project logframe document is accessible at: <https://hdl.handle.net/10568/82852>. Where a sub-activity is missing in the serialization (e.g., 1.1.1.1), it means that the sub-activity was completed in the previous years. The presented ones are either continuing (sometimes re-worded to reflect the advancement or adaptation) or new sub-activities.

**Table 2:** Logframe overview

|  |  |
| --- | --- |
| Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability | |
| Output 1.1: Demand-driven, climate-smart, integrated crop-livestock research products (contextualized technologies) for improved productivity, diversified diets, and higher income piloted for specific typologies in target agro-ecologies and scaled in Outcomes 4 and 5 | |
| Activity 1.1.1: Assess and iteratively improve resilient crop-crop and crop-livestock integration systems [Assess and iteratively improve crop-livestock combinations from Phase I] | 1.1.1.2 Investigations on the medium to long-term impacts of SI technologies (improved soil fertility management, improved germplasm, crop combinations, nutrient and water management) on crop productivity on multi-locational field sites and baby trials |
| 1.1.1.5: Determining the productivity and resilience benefits of Gliricidia-based cropping systems |
| 1.1.1.6 Assess the uptake and adaptation of new crop configurations- (Mbili Mbili technology)- and understand the influencing factors |
| 1.1.1.8 Exploring the sustainable intensification pathways of farming system case studies in Tanzania and assessing the impact of Africa RISING technologies on resilience |
| Activity 1.1.2: Evaluate and implement pathways that are effective at improving access to seeds and clonal materials of modern varieties of legumes, cereals, vegetables, forages and livestock | 1.1.2.1 Assessment of the benefits of management technologies on performance of improved vegetable varieties |
| Output 1.2: Demand-driven, labor-saving and gender-sensitive research products to reduce drudgery while increasing labor efficiency in the production cycle piloted for relevant typologies in target areas [and scaled in Outcomes 4 and 5] | |
| Output 1.3: Tools (including ICT-based) and approaches for disseminating recommendations in relation to above research products, integrated in capacity development [and used in Outcomes 4 and 5] | |
| Activity 1.3.1: Conduct extrapolation domain analysis based on GIS, agro-ecology, and crop model-generated information to establish the potential of technologies for geographical reach | 1.3.1.1 Farmer/Extension messaging to scale-out Africa RISING technologies (forage production and use, crop residue processing and use and feed rations) using MWANGA and engagement of public and private sector partners for ownership of MWANGA |
| 1.3.1.2 Refine regionally relevant extrapolation domain maps for validated conservation agriculture (CA) practices |
| 1.3.1.3 Produce regionally relevant extrapolation domain maps for validated SWC agriculture practices |
| Outcome 2: Natural resource integrity and resilience to climate change enhanced for the target communities and agro-ecologies | |
| Output 2.1: Demand-driven research products for enhancing soil, land and water resources management to reduce household/community vulnerability and land degradation piloted in priority agro-ecologies [and scaled in Outcome 5] | |
| Activity 2.1.1: Characterize current practices in ESA through identifying formal and informal arrangements for access to and use of water and land resources | 2.1.1.1 Assessing the buffer and adaptative capacity to harness the resilience of different farm types |
| Output 2.2: Innovative options for land and water management in selected farming systems demonstrated at strategically located learning sites [and scaled in Outcome 5] | |
| Activity 2.2.1 Set up demonstration and learning sites in target ESA communities | 2.2.1.2 Investigations on nutrient and water management for climate resilience along a climate gradient in southern Malawi |
| 2.2.1.6 Validation of residual tied ridging as a labor-saving technology in semi-arid Areas of Central Tanzania |
| Outcome 3: Food and feed safety, nutritional quality, and income security of target smallholder families improved equitably (within households) | |
| Output 3.1: Demand-driven research products to reduce post-harvest losses and improve food quality and safety piloted in target areas [and scaled in outcome 5) | |
| Activity 3.1.1 Conduct packaging and delivery of post-harvest technologies through community and development partnerships with iterative review, refining and follow-up | 3.1.1.1 Assess the impact of nutritional messaging on farmers' nutritional knowledge, attitude and practices and household nutrition status, in partnership with Islands of Peace |
| 3.1.1.2 Evaluate the influence of farmer storage structures and environment on the physical and economic losses abatement by hermetic storage devices |
| Output 3.2: Nutritional quality improved through increased accessibility and use of nutrient-dense crops and livestock products | |
| Activity 3.2.1: Promote and deploy nutrient-rich crop varieties and livestock feed resources in target communities | 3.2.1.1. Elucidate pathways to sustainable adoption of nutrient diets and aflatoxin mitigation practices in rural communities of Central Tanzania |
| Outcome 4**:** Functionality of input and output markets and other institutions to deliver demand-driven sustainable intensification research products improved | |
| Output 4.1: Access to profitable markets for smallholder farming communities and priority value chains facilitated | |
| Activity 4.1.1 Conduct comprehensive value-chain analysis with specific focus on SI technologies | 4.1.1.2 Enhancement of the groundnut seed value chain in central Tanzania: Imperatives for improving functionality |
| 4.1.1.4 Assess how livelihoods of farmers are affected by the implementation of ISFM practices as a result of Africa RISING activities in Kongwa |
| 4.1.1.5 Value chain analysis of nutrient-dense common bean varieties in Malawi |
| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | |
| Output 5.1: Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | |
| Activity 5.1.1: Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations | 5.1.1.1 Continued experimentation in 6 target communities of Eastern Zambia and nine communities in Central and Southern Malawi with already established clustered CA trials |
| 5.1.1.2 Explore the productivity domains of selected legumes and cereals to elucidate their best fitting cropping system at community/landscape level and their dissemination |
| 5.1.1.4 (a &b) Case-studies: Application of SI technology use among farmers interacting with Africa RISING at different intensities |
| 5.1.1.5 Panel survey, soils processing and meta-analysis studies for maize-grain legumes sequences and implications for sustainability |
| Activity 5.1.2 Use farm trial data to apply crop simulation models (APSIM) and assess performance over space and time, including assessment of climate-smart technologies to establish the potential for adaptation and mitigation | 5.1.2.1 Apply APSIM crop simulation model to assess changes in resource use efficiencies, productivity and profitability of the different cropping systems in Kongwa, Kiteto and Iringa in Tanzania |
| 5.1.2.2 Evaluate the potential contributions of integrated soil-fertility management around the five SIAF domains with emphasis on Africa RISING interventions in Tanzania |
| 5.1.2.3 Synthesizing information, knowledge, and tools Africa RISING - ESA has generated over its lifetime (10 years) guided by the Sustainable Intensification Assessment Framework (SIAF), |
| Activity 5.1.6: Disseminate best-fit integrated crop-livestock technologies to reach and have effect on small-scale farmers in a landscape context | 5.1.6.1 Small-scale piloting of FarmMATCH – a framework for typology-based targeting and scaling of agricultural innovations. (Matching Agricultural Technologies to Farms and their Context) |
| Cost-benefit and gender analysis coupled with other socioeconomic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts | 5.1.7.5 Determine the effect of the joint adoption of improved maize varieties and maize-legume rotation on maize productivity and crop incomes in Malawi |
| 5.1.7.6 Determine the impact of the Africa RISING research on household welfare and return on investment |
| 5.1.7.7 Scaling Sustainable intensification technologies: Lessons from three case studies in Malawi and Zambia |
| Output 5.2: Strategic partnerships with public and private, initiatives for the diffusion, and adoption of research products established | |
| Activity 5.2.1 Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways | 5.2.1.1 Engage able and willing partners to develop a strategy and implementation framework for scaling up intensification research technologies in semi-arid ecologies of central Tanzania |
| Activity 5.2.2: Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways | 5.2.2.1 Support the Ministry of Agriculture and NGO extension in scaling CA systems in Eastern Zambia and Malawi |
| 5.2.2.6 Partnership with Islands of Peace for increasing the adoption of good agricultural practices (GAP) in vegetable production and improving nutrition |
| 5.2.2.7 Partnership with LEAD Foundation to take to scale soil and water management technologies in erosion-prone areas of Central Tanzania |
| Output 5.3: Gender-sensitive decision support tools for farmers to assess technology-associated risk and opportunities used by partners | |
| Activity 5.3.1: Identify and communicate gender-sensitive decision support technologies in the context of different farm typologies | 5.3.1.1 Role of gender from farm-to-fork and the market of grain legumes and dryland cereals in Kiteto and Kongwa (data already collected and partly presented; more in-depth analysis needed) |
| 5.3.1.2 Identify and communicate gender-sensitive decision support tools in the context of different farm typologies |
| Output 5.4: A technology adopt monitoring, evaluation, and learning framework for use by the project team and scaling partners released [led by IFPRI and used by project partners] | |
| Activity 5.4.1 Monitor and modify the progress of technology adoption process towards scaling | 5.4.1.1 Populate the Beneficiary and Technology Tracking Tool (BTTT) Tanzania, Malawi, and Zambia with information about Africa RISING technologies applied, and farmers/households engaged in validating the technologies |
| 5.4.1.2 Populate the technology scaling tool with detailed information on scaling data for Tanzania, Malawi, and Zambia |
| 5.4.1.3 Design simple research rack up database and populate it with research rack up data for Tanzania, Malawi, and Zambia) |
| 5.4.1.5 Provide additional capacity building and work with ESA research partners to ensure timely (and complete) submission of FTF indicators data, research rack up data, country narratives, IM performance narratives for Fiscal Year 2021, compliance with the Africa RISING Data Management Plan (Dataverse data uploading and sharing) |

Planned work

The planned activities are presented in the protocols. Activities under each protocol aim to achieve the outputs under the four outcomes in the project logframe (see Table 2).

Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability

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| --- | --- | --- | --- | --- |
| Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability | | | | |
| a. Output 1.1 | Demand-driven, climate-smart, integrated crop-livestock research products (contextualized technologies) for improved productivity, diversified diets, and higher income piloted for specific typologies in target agro-ecologies | | | |
| b. Activity 1.1.1 | Assess and iteratively improve resilient crop-crop and crop-livestock integration systems | | | |
| c. Sub-activity 1.1.1.2- | Investigations on the medium to long term impacts of SI technologies (improved soil fertility management, improved germplasm, crop combinations, nutrient and water management) on crop productivity on multi-locational field sites | | | |
|  | | | | |
| d. Research team | | | | |
| Name | Institution | Role | | |
| Regis Chikowo | MSU | PI, research conceptualization, design, implementation | | |
| Sieg Snapp | MSU | Research conceptualization, design | | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s) | Linthipe, Golomoti, Kandeu, Extension Planning Areas (EPAs) | | | |
|  |  | | | |
| g. Start date | Continue with two mother trials in each site that were established between 2012 and 2014 | | | |
|  |  | | | |
| h. End date | 30 August 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| Long-term on-farm trials are rare in Africa. Soil organic carbon (SOC) is one of the most critical soil health indicators yet changes slowly, rendering short-term (3-5 years) field experiments ineffective for studying the impacts of SI technologies on SOC. Africa RISING established field experiments in 2012 with a range of SI technologies, including integrating grain legumes as intercrops or in rotations with maize. Our data shows that these systematic intercrops or rotations allow farmers to achieve high and stable maize yields with modest fertilizer investments under varying rainfalls. This is critical for resource-poor farmers who have limited access to mineral fertilizers. Our interventions resulted in demonstrable knowledge among farmers on sustainable intensification approaches that integrate legumes. For example, we have seen farms that once had few grain legume components getting diversified and enabling systematic crop rotations. Recently we have applied stability analysis to assess the impact of grain legume integration on maize grain yield, yield stability, nitrogen use efficiency (NUE), and ability to meet household protein requirements.  This sub-activity has anchored our action research, resulting in over 4,000 baby farmers increase productivity and expanding the area under SI technologies. More details on these experiments are outlined in the following publications: Smith *et al*. 2016[[1]](#footnote-2), Snapp *et al*. 2018[[2]](#footnote-3), Chimonyo *et al*. 2019[[3]](#footnote-4), Gwenambira-Mwika et al. 2021[[4]](#footnote-5), John Innocensia et al. 2021[[5]](#footnote-6). This sub-activity presents a rare opportunity to apply SI technologies on-farm beyond a ‘decade’ at multi-locational sites.  These long-term experiments (LTEs) are rare, critical, and a significant Africa RISING legacy product. We expect substantial future investments around these trials from the Excellence in Agronomy (EiA) initiative, which has already expressed interest. We continue to use data from these trials as the best proxy for water-limited yield potential using the NPK + manure treatment. | | | | |
|  | | | | |
| 2. Objectives | | | | |
| 2.1 To evaluate the long-term effects of rotating legumes with maize and other nutrient management options at medium to long-term mother trials (we monitored for a decade the SOC building up on-farm, which is informative for the potential of SOC sequestration and sustainability) | | | | |
|  | | | | |
| 3. Research questions/ hypotheses | | | | |
| 3.1 Do legume-cereal cropping sequences increase labile SOM fractions that largely explain improved efficiencies during the cereal cropping phase? | | | | |
| 3.2 Do cropping sequences that integrate the deep-rooted semi-perennial pigeonpea promote more uniform soil profiles bulk densities, and better rooting and nutrient uptake by sequenced crops? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| In these experiments initiated in 2012, we investigate SOC changes over time for treatments that range from an unfertilized control, maize fertilized with NP optimally every year, and when legumes are integrated as intercrops or rotations with maize. All treatments are replicated three times. The primary data to be collected will be grain yield and biomass productivity. We will harvest on a whole plot basis when farmers are involved in harvesting and participatory evaluation of the technologies or the traditional net–plot harvest in some cases. The protein and calorie production from the various technologies will be used to inform the utility of the technologies regarding the human condition domain.  The N-difference method will be used to estimate biological N2-fixation. Recently we have applied stability analysis to assess the impact of grain legume integration on maize grain yield, yield stability, nitrogen use efficiency (NUE), and ability to meet household protein requirements. More details on these experiments are outlined in the publications by Smith *et al*. 2016[[6]](#footnote-7), Snapp *et al*. 2018[[7]](#footnote-8), Chimonyo *et al*. 2019[[8]](#footnote-9), and the Research Protocols for 2019-2020. | | | | |
|  | | | | |
| 5. Data (with metrics) to be collected and uploaded on DataVerse | | | | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method | Responsible | | Productivity | | | | | | | | *Maize grain productivity* | Maize grain and biomass yield (kg/ha/season) | Maize production (kg/ha/season) |  |  | Yield measurements | MSU | | *Maize biomass productivity* | Legume grain and biomass yield (kg/ha/season | Maize residue production (kg/ha/season) |  |  | Yield measurements | MSU | | *Legume productivity* | Soybean/groundnut grain and biomass yield (kg/ha/season); |  |  |  | Yield measurements | MSU | | *Yield gap* | Yield gap for maize, soybean, groundnuts (kg/ha/season) |  |  |  | Yield measurement | MSU | | Economic | | | | | | | | *Profitability* | Net income ($/crop/ha/season) |  |  |  | Survey |  | | *Income diversification* |  |  | Number of income sources |  | Survey |  | | Environmental | | | | | | | | *Soil biology* | Soil organic carbon (g/kg) |  |  |  | Laboratory testing | MSU | | *Soil chemical quality* | Biological N2-fixation(kg/ha) | Biological N2-fixation (kg/farm) |  |  | Direct measurement | MSU | | Human condition | | | | | | |  | | *Nutrition* | Protein production (g/ha); |  |  |  | Lookup tables | MSU | | *Food security* | Food production  (calories/ha/year) |  | Months of food insecurity |  | Survey | MSU | | Social | | | | | | | | *Gender equity* | Rating of technologies by gender |  |  |  | Participatory evaluation | MSU | | *Equity (generally)* | Capacity (access to information) |  |  |  | Participatory evaluation |  | | | | | |
|  | | | | |
| 6. Deliverables | | | Means of verification | Delivery date |
| 6.1 Two established SI field trials for each site | | | List of field trials, host farmer names available | Jan. 2021 |
| 6.2 Benefits of SI technologies evaluated across sites and documented through a scientific publication | | | Residue management manuscript submitted or published | Aug. 2022 |
| 6.3 At least one field day per EPA conducted | | | Field day reports | May 2022 |
| 6.4 Translate scientific publications material (e.g., the Field Crops Research “Broadening SI options paper…’ into a Policy brief on SI options | | | Policy brief produced | Jul. 2022 |
| 6.5 Africa RISING attends the Mwapata Annual Policy Conference and presents the policy brief, and other legacy products for SI approaches | | | Proceedings of the Mwapata meeting with Africa RISING input | Aug. 2022 |
|  | | | | |
| 7. How will scaling be achieved? | | | | |
| Malawi extension system (District Agricultural Extension Coordinating Committees=DAECC) that oversees technology dissemination at the district level will help disseminate technologies in Extension Planning Areas (EPAs) not covered by the Africa RISING project.  The DAECC constitutes a network that includes the district-level government extension system and all NGOs operating in the district. The composition of the DAECC is dynamic. This body harmonizes agricultural technologies dissemination approaches and improves the efficiency of use/allocation of financial resources by different actors in the different EPAs | | | | |

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| 8. How are the activities in this protocol linked to those of others? |
| Choice of crop varieties has been harmonized based on experiences and technical advice from ICRISAT. Increased productivity of grain legumes based on this sub-activity is directly linked to nutrition studies that have been implemented. |

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| 9. Gantt chart | | | | | | | | | | |
| Year/month | 2021 | | 2022 | | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Procurement of inputs |  |  |  |  |  |  |  |  |  |  |
| IITA –MSU contract/inputs distribution |  |  |  |  |  |  |  |  |  |  |
| Establishment of trials/soil sampling (2 mother trials per each of 3 EPA) |  |  |  |  |  |  |  |  |  |  |
| Field assessments/data collection |  |  |  |  |  |  |  |  |  |  |
| Fields days (vegetative stage/maturity stage) |  |  |  |  |  |  |  |  |  |  |
| Harvesting of trials |  |  |  |  |  |  |  |  |  |  |
| Post-harvest workshops /feedback meetings |  |  |  |  |  |  |  |  |  |  |
| DataVerse data upload |  |  |  |  |  |  |  |  |  |  |
| Report writing/publications |  |  |  |  |  |  |  |  |  |  |

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| Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability | | | | | | | | | | | |
| a. Output 1.1 | | | | Demand-driven, climate-smart, integrated crop-livestock research products (contextualized technologies) for improved productivity, diversified diets, and higher income piloted for specific typologies in target agro-ecologies | | | | | | | |
| b. Activity 1.1.1 | | | | Assess and iteratively improve resilient crop-crop and crop-livestock integration systems | | | | | | | |
| c. Sub-Activity 1.1.1.5 | | | | Determining the productivity and resilience benefits of Gliricidia-based cropping systems | | | | | | | |
|  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | |
| Name | | | Institution | | Role | | | | | | |
| Anthony Kimaro | | | ICRAF | | Leading development of a nutritional interaction manuscript and biophysical data processing and analysis, supervising the development of other agroforestry publications, and contributing to regional/system-based manuscripts development | | | | | | |
| Emmanuel Temu | | | ICRAF | | Leading processing and analysis of adoption and socio-economic data and developing a working paper from these studies | | | | | | |
| Martha Swamila | | | SUA | | Lead manuscripts on profitability and risk analysis of Gliricidia-Maize intercropping | | | | | | |
| Julius Manda | | | IITA | | Contributing to the profitability of Gliricidia-Maize system manuscript | | | | | | |
| Johannes Hafner | | | Humboldt University | | Leading a manuscript on biomass equations for *G. sepium* and pigeonpea | | | | | | |
| Christine Lamanna | | | ICRAF | | Contributing to the profitability of Gliricidia-Maize system manuscript and Contributing to the technology brief on maize-G. sepium intercropping | | | | | | |
| Todd Rosenstock | | | Alliance Bioversity-CIAT | | Contributing to a manuscript on nutrition and resource use efficiency of maize intercropped with G. sepium and pigeonpea and a manuscript on biomass equations for *G. sepium* and pigeonpea. | | | | | | |
| Daniel Mgalla | | | IITA | | Monitoring of the research activities to ensure compliance with the FtF monitoring system | | | | | | |
|  | | | | | | | | | | | |
| e. Student(s): Nil | | | | | | | | | | | |
|  | | | | | | | | | | | |
| f. Locations | Manyusi, Mlali, and Moleti villages in Kongwa District | | | | | | | | | | |
|  | | | | | | | | | | | |
| g. Start date | October 2015 | | | | | | | | | | |
|  | | | | | | | | | | | |
| h. End date | September 2022 | | | | | | | | | | |
|  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | |
| Agroforestry research in Kongwa District, Dodoma, Tanzania, has focused on assessing drought resilience and long-term productivity of *Gliricidia sepium*-based cropping systems (Sub- Activity 1.1.1.5) and the evaluation of land rehabilitation effects of the contour farming technology integrated with fodder crops. Significant achievements of this work include training seven graduate students and publishing five peer-reviewed journal articles and two book chapters. Also, farmers and scaling and research partners are taking the tested agroforestry technologies beyond the Africa RISING sites. For instance, the Lead Foundation has trained over 825 champion farmers in the six districts of the Dodoma region to integrate trees on contours and other soil and water conservation technologies for multiple benefits, including land rehabilitation, increased crop yields, and household income to improve the adaptive capacity of farmers (Kimaro et al., 2019[[9]](#footnote-10); Kizito et al. 2022[[10]](#footnote-11)); and fodder and fuelwood supply (Nassoro et al., 2015[[11]](#footnote-12); Hafner et al., 2020[[12]](#footnote-13)). Farm Africa purchased and planted 10,000 seedlings of *G. sepium* in their climate-smart agriculture project sites during the 2021 cropping season after being introduced to validated agroforestry technologies by the Africa RISING lead farmer in Ngumbi village. The new watershed project in Dodoma led by ICRISAT has an agroforestry component. During the 2022 growing season, LEAD foundation plans to plant at least 30,000 seedlings of *Gliricidia sepium* in 10 villages under their partnerships with the ICRISAT led watershed project and TARI-Makutupora under the Africa RISING project. This scaling operation aims to rehabilitate degraded farmland and forest lands using landscape technologies, including agroforestry technologies (contour with fodder crops and woodlot) introduced in the Kongwa district by ICRAF under the Africa RISING project. These initiatives demonstrate that agroforestry is gaining attention after farmers and research and scaling partners have observed promising results of biophysical and socio-economic benefits in demonstration and experimental plots (Kimaro et al., 2019; Renwick et al., 2020[[13]](#footnote-14); Kizito et al., forthcoming).  Before Africa RISING worked in Kongwa and Kiteto Districts, little to no agroforestry research and development activities occurred in these districts. Our research suggests that the key determinant factors for broader adoption are high initial costs of the establishment, land tenure, extension services, and the knowledge-intensive and long-term nature of agroforestry technologies (Swamila et al., 2020[[14]](#footnote-15); Bruck and Kuusela, 2021[[15]](#footnote-16)). Thus, farmers, scaling partners, and extension officers with insufficient knowledge of the technical specifications may fail to realize the potential benefits observed in the demonstration and research plots during the implementation period of the Africa RISING project. The extension system in Tanzania and other countries in East and Southern Africa have limited knowledge, yet extension officers play a significant role in backstopping adopters of the technologies. Developing agroforestry communication materials (e.g., extension manuals and technology labels) in a format that can be easily understood by decision-makers, farmers, and extension officers will help to mitigate the knowledge gap in the agricultural extension system and create the enabling environment to support the ongoing scaling work by Africa RISING scaling partners.  ICRAF proposes developing and disseminating an agroforestry extension manual for validated technologies and a technology label on maize-G. sepium intercropping to backstop farmers, research, and scaling partners and to increase awareness among decision-makers interested in promoting the adoption of agroforestry technologies tested and validated by the Africa RISING program. These activities will translate knowledge published in journal articles and synthesize additional information from archived data into a form that the end-users can understand. A new manuscript on risk analysis of Maize-G. sepium intercropping will also be developed and submitted for publication. The workplan will be implemented with the following pending deliverables from the 2020-2021 workplan: three manuscripts for journal publication [Profitability of agroforestry technologies by Swamila et al. (202x), Biomass equations of *G. sepium* and pigeonpea by Hafner et al. (202x), and plant nutrition and resource use efficiency by Kimaro et al. (202x)], and a working paper on agroforestry adoption (Temu et al., 202x). | | | | | | | | | | | |
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| 2. Objectives | | | | | | | | | | | |
| 2.1 To develop and disseminate communication products on maize-G. sepium intercropping in semiarid areas | | | | | | | | | | | |
| 2.2 To finalize pending deliverables from the 2020/21 workplan | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 3. Research questions (based on the manuscripts under development) | | | | | | | | | | | |
| How does intercropping maize with *G. sepium* and/or pigeonpea influence productivity, drought resistance, resource use efficiency, and profitability of maize-based cropping systems in semi-arid areas? | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | |
| Experiment design, implementation, and data analysis:  The manuscripts and a working paper under development use data from the maize drought resistance experiment and farmer-managed (demonstrations) trials.  Development of the agroforestry extension manual and a technology label on maize-G. sepium intercropping will involve visits to new scaling sites to collect information and take photos, review Africa RISING publications and other literature related to the following agroforestry technologies tested and validated by ICRAF in Kongwa and Kiteto Districts   * Intercropping of *G. sepium* and pigeonpea with maize and/ or Sorghum ([Kimaro et al., 2019](https://link.springer.com/chapter/10.1007/978-3-319-92798-5_13); Renwick et al., 2020; Hafner et al., 2020) * Conservation Agriculture with Trees (Kimaro et al. 2016[[16]](#footnote-17); Liingilie, 2019[[17]](#footnote-18)) * Contour farming with fodder crops (Kizito et al. 202x) * Shelterbelt for windbreak and erosion control ([Kimaro et al., 2019](https://link.springer.com/chapter/10.1007/978-3-319-92798-5_13)) * Woodlot for fodder and firewood supply ([Kimaro et al., 2019](https://link.springer.com/chapter/10.1007/978-3-319-92798-5_13)) | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse), | | | | | | | | | | | |
| Domain & *Indicator* | | Field/plot level metrics | | | | Farm level metrics | | Household level metrics | Community/ landscape metrics | Measurement method | |
| No data collection is planned, only write-up of publications | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 6. Deliverables | | | | | | | Means of verification | | | | Delivery date |
| 6.1 Manuscript on the biomass equation for predicting wood and foliage biomass of *G. sepium* and pigeonpea in intercropping | | | | | | | Manuscript published in a journal | | | | 30 Nov. 2021 |
| 6.2 Manuscript on the profitability of *Gliricidia* intercropping experiment at Manyusi | | | | | | | Manuscript verified by the Chief Scientist  and submitted for publication in a journal | | | | 31 Dec. 2021 |
| 6.3 Manuscript on risk analysis of Maize-*G. sepium* intercropping | | | | | | | Manuscript verified by the Chief Scientist  and submitted for publication in a journal | | | | 30 Jun. 2022 |
| 6.4 Manuscript on nutrition and resource use efficiency of maize (fertilizer and rainwater) in *G. sepium* intercropping | | | | | | | Draft manuscript verified by the Chief Scientist  and submitted for publication in a journal | | | | 30 Jun. 2022 |
| 6.5 Working paper on the adoption and socio-economic impacts of agroforestry technologies | | | | | | | Manuscript verified by the Chief Scientist  and published on the website | | | | 30 Jun. 2022 |
| 6.6 Extension manual on validated agroforestry technologies | | | | | | | Draft verified by the Chief Scientist  and Communication experts and posted on the website | | | | 30 Jun. 2022 |
| 6.7 Technology label on Maize-Gliricidia Intercropping | | | | | | | Draft verified by the Chief Scientist  and Communication experts and published on the website | | | | 31 Mar. 2022 |
| 6.8 Develop a technology label on contour farming with fodder crops (for sub-activity 2.2.1.4) | | | | | | | Technology label published | | | | 31 Mar. 2022 |
|  | | | | | | | | | | | |
| 7. How will scaling be achieved? | | | | | | | | | | | |
| The technology brief and the agroforestry extension manual will be disseminated during national meetings, including the Nane Nane agricultural show, published on the websites of Africa RISING and ICRAF, and shared with NGOs working on agroforestry in Tanzania (e.g., [Vi-Agroforestry](https://viagroforestry.org/where-we-work/tanzania/), LEAD Foundation, Farm Africa, Sustainable Agriculture Tanzania - [SAT](https://kilimo.org/)). The partnerships of LEAD foundation with TARI-Makutupora and the planting of 30,000 seedlings of *G. sepium* according to their 2022 planting target. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | | | | | | |
| This sub-activity activity is directly linked to the following sub-activities:   * Sub-activity 2.2.1.7 Demonstrate technologies on soil and water conservation for enhancing resilience to climate change in semi-arid agro-ecologies of Central Tanzania. (Contour with fodder crops) * Sub-activity 2.2.1.3: Evaluating potential contributions of integrated soil fertility management around the five SIAF domains, emphasizing Africa RISING interventions in Tanzania. (Maize-GS-PP Intercropping) * 5.2.2.7 Partnership with LEAD Foundation to take to scale soil and water management technologies in erosion-prone areas of Central Tanzania (Scaling agroforestry technologies) * 5.1.2.1 Apply APSIM crop simulation model to assess changes in resource use efficiencies, productivity, and profitability of the different cropping systems in Kongwa, Kiteto, and Iringa in Tanzania (Profitability paper) | | | | | | | | | | | |

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| 9. Gantt chart | 2021 | | 2022 | | | | | | | | |
| Activity/ month | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Finalize and publish the biomass equation paper |  |  |  |  |  |  |  |  |  |  |  |
| Finalize and submit a manuscript on *G. sepium* profitability paper |  |  |  |  |  |  |  |  |  |  |  |
| Develop and submit a manuscript on risk analysis of Maize-*G. sepium* intercropping |  |  |  |  |  |  |  |  |  |  |  |
| Develop two technology labels |  |  |  |  |  |  |  |  |  |  |  |
| Develop and submit a manuscript on plant nutrition and resource use efficiency in *G. sepium* intercropping |  |  |  |  |  |  |  |  |  |  |  |
| Developing and submitting a working paper on the adoption and socio-economic impacts of agroforestry technologies |  |  |  |  |  |  |  |  |  |  |  |
| Develop an extension manual on validated agroforestry technologies |  |  |  |  |  |  |  |  |  |  |  |
| Disseminate communication products during Nane Nane and other national outlets |  |  |  |  |  |  |  |  |  |  |  |
| Technical reports writing |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability | | | | |
| a. Output 1.1 | Demand-driven, climate-smart, integrated crop-livestock research products (contextualized technologies) for improved productivity, diversified diets, and higher income piloted for specific typologies in target agro-ecologies | | | |
| b. Activity 1.1.1 | Assess and iteratively improve resilient crop-crop and crop-livestock integration systems | | | |
| c. Sub-Activity 1.1.1.6 | Assess the uptake and adaptation of new crop configurations- (Mbili Mbili technology)- and understand the influencing factors | | | |
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| d. Research team | | | | |
|  | Institution | Role | | |
| Job Kihara | Alliance Bioversity CIAT | PI | | |
| Jonas Julius/Rose Anael | MoA | Organize field days and supervise field operations by farmers | | |
| Daniel Mgalla | IITA | Provide support in monitoring of the research activities to ensure compliance with the FtF monitoring system including periodically assisting in data collection (both FtF and custom indicators data) with a critical gender perspective and uploading into the FtF system | | |
|  | | | | |
| e. Student(s) | | | | |
| Name | Institute | Degree | Start | End |
| Michael Kinyua | CIAT/Kenyatta University | Ph.D. | 2019 | 2022 |
|  | | | | |
| f. Location(s) | Seloto, Sabilo, Gallapo in Babati District, Tanzania | | | |
|  |  | | | |
| g. Start date | |  | | --- | | December 2018 | | | | |
|  |  | | | |
| h. End date | August 2022 | | | |
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| 1. Justification | | | | |
| The Mbili Mbili technology has been tested in researcher-designed farmer-managed experiments for the last three years. The Mbili Mbili technology aims to increase the productivity of the often-neglected legume component while maintaining the same high yield of maize, thereby improving the overall system (i.e., considering the three crops) economics and household food nutritional security. A survey and focus group discussions were undertaken during 2019/2020 to understand household social dynamics caused by the technology. In 2020-2021, an in-depth survey activity was conducted to understand the technology uptake and the adaptations done by farmers. The in-depth survey and information from the focus group discussions allow (i.e., ongoing data analyses) to contextualize technology uptake and extent of use, for example, in relation to knowledge access and collective action, etc. At the same time, six on-farm trials on Mbili Mbili have been maintained and generated data on the opportunities to maximize the productivity and profitability of the intercropping system as part of the Ph.D. studies by Michael Kinyua (protocols for this were submitted in the last planning cycle). The trials include CIMMYT tested and proven Meru 513 maize variety with vertical architecture, maize topping, stripping of lower leaves, Mbili Mbili, and the double-up legume technology successfully tested in Malawi. The research generated positive results. Therefore, it is important to deliver this technology to existing farmer groups as a close-out activity on the uptake of the Mbili Mbili technology with Africa RISING coming to an end. We propose to work with 20 farmer groups to demonstrate the Mbili Mbili technology as an integrated system with stripping and topping. | | | | |
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| 2. Objectives | | | | |
| 2.1. Deliver an integrated Mbili Mbili technology with accompanying practices of stripping and topping to farmer groups in Babati as a closeout activity on uptake of Mbili Mbilitechnology implementation by farmer groups | | | | |
| 2.2 Undertake farmer field days with farmer groups to offer training on Mbili Mbili and the accompanying practices | | | | |
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| 3. Research questions | | | | |
| 3.1 What are the learnings obtained in demonstrations and implementation of Mbili Mbili by different farmer groups? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| Mbili-Mbili learning sites integrating strippings and toppings will be undertaken in 20 existing farmer groups whose membership varies mainly from 10 to 30 farmers. The learning sites will have a 0.5-acre plot of the Mbili Mbili technology. Group members will have joint laying out, planting, and harvesting. Additionally, a field day will be organized, bringing together members of different farmer groups. One hundred fifty farmers are targeted to participate in the field days, and a video of the day capturing key highlights will be developed as a legacy product. Focus group discussions will also be organized to capture group challenges and learnings in implementing the Mbili Mbili system and accompanying practices. | | | | |
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| 5. Data to be collected and uploaded on Dataverse | | | | |

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| Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape level metrics | Measurement method (details in research protocol) |
| Productivity | | | | | |
| *Crop productivity* | Maize, beans, pigeonpea, and cowpea productivity (kg/ha/  season) |  |  |  | Farmer evaluation |
| *Economics* | | | | | |
| *Profitability* | Gross margins ($/crop/ha/ season) |  |  |  | Farmer evaluation |
| Labor requirements | Farmer rating of labor |  |  |  | Farmer evaluation |
| Environment | | | | | |
| *Fuel availability, soil* | Fuel biomass (kg/ha/season) |  |  |  | Farmer evaluation |
| Human condition | | | | | |
| *Capacity to experiment* |  |  |  | % of farmers  experimenting | FGDs |
| *Food security* |  |  | Months of food insecurity; Rating of food security |  | Farmer evaluation |
| Social | | | | | |
| *Gender equity* |  |  |  | Rating of technologies by gender (capturing perceptions) | Farmer evaluation |

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| 6. Deliverables | Means of verification | Delivery date |
| 6.1 20 farmer groups in Babati successfully implement Mbili-Mbili as an integrated practice with stripping and topping, and their learnings/insights on group implementation of Mbili-Mbili are obtained | Research reports | Aug. 2022 |
| 6.2 Farmer field days are conducted with at least 150 farmers | Field day video | Aug. 2022 |
| 6.3 Implementation guide for Mbili-Mbili as an integrated practice | Implementation guide | Aug. 2022 |
| 6.4 Scientific analysis of Mbili system performance relative to other practices (double up legume, farmer practices), household social dynamics, and farmer adaptations of the system | Journal article (on previous budget) | Aug. 2022 |
| 6.5. Draft Ph.D. thesis on Mbili Mbili crop configuration system | Draft Ph.D. thesis (Michael Kinyua) | Aug. 2022 |
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| 7. How will scaling be achieved? | | |
| We have developed a field guide that contains the Mbili Mbili practices. Besides, we will now demonstrate the performance of Mbili Mbili to farmer groups for them to act as the nucleus of uptake of Mbili Mbili beyond Africa RISING. We will also utilize the Mwanga ICT platform to communicate agronomic information, including Mbili Mbili. We partner with Meru Agro Seed Company to deliver Improved maize seeds and provide advice to farmers. We are also partnering with the Minjingu fertilizer company to educate farmers on fertilizer use in production. | | |
|  | | |
| 8. How are the activities in this protocol linked to those of others? | | |
| The Mbili Mbili technology borrows from the Double-up legumes’ work implemented in Kongwa-Kiteto and Malawi. Stripping and topping practices support livestock feed provisioning (ILRI and TALIRI) and are also important for farm-level assessments, e.g., the work of Lieven and farming systems colleagues. | | |

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| 9. Gantt chart | | | | | | | | | |
| Year/month | 2021 | 2022 | | | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| 1. Mwanga database update |  |  |  |  |  |  |  |  |  |
| 2. Co-development of Mwanga messages and messaging |  |  |  |  |  |  |  |  |  |
| 3. Survey instrument development |  |  |  |  |  |  |  |  |  |
| 4. Implementation of survey |  |  |  |  |  |  |  |  |  |
| 5. Video content development |  |  |  |  |  |  |  |  |  |
| 6. Village scientific synthesis and feedback meetings |  |  |  |  |  |  |  |  |  |
| 7. Feedback story development (Eveline) |  |  |  |  |  |  |  |  |  |
| 8. Two bi-annaul progress reports |  |  |  |  |  |  |  |  |  |

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| Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability | | | | | | |
| a. Output 1.1 | Demand-driven, climate-smart, integrated crop-livestock research products (contextualized technologies) for improved productivity, diversified diets, and higher income piloted for specific typologies in target agro-ecologies [and scaled in Outcomes 4 and 5] | | | | | |
| b. Activity 1.1.1 | Assess and iteratively improve crop-livestock systems | | | | | |
| c. Sub-activity 1.1.1.8 | Exploring the sustainable intensification pathways of farming system case studies in Tanzania and assessing the impact of Africa RISING technologies on resilience | | | | | |
|  |  | | | | | |
| d. Research team: | | | | | | |
| Name | Institution | Role | | | | |
| L. Claessens | IITA | PI, coordination, systems research, SIAF, FarmDESIGN, MSc student supervision | | | | |
| J. Manda | IITA | Economics, 2020 household survey (post-harvest) | | | | |
| J. Groot | WUR | FarmDESIGN modeling, MSc student supervision | | | | |
| All with past and ongoing activities in Tanzania | ICRAF, ICRISAT, WorldVeg, CIAT, CIMMYT, SUA, TARI, TALIRI | Knowledge and data exchange (and new experimental data collection budgeted in their own activities?) | | | | |
|  | | | | | | |
| e. Student(s) | | | | | | |
| Name | Institute | Degree | | Start | End | |
| Sergi Domenech Carbo | WUR | MSc | | November 2021 | May 2022 | |
|  | | | | | | |
| f. Location(s): | Babati, Kilolo, Kongwa, and Mbozi districts in Tanzania (570 Households surveyed in 2020) | | | | | |
|  | | | | | | |
| g. Start date | October 2018 | | | | | |
|  | | | | | | |
| h. End date | September 2022 | | | | | |
|  | | | | | | |
| 1. Justification  The main Sustainable Intensification (SI) innovations researched, validated, and promoted in the Africa RISING program over the last ten years are: post-harvest technologies, improved crop varieties, climate-smart land management practices (e.g., SWC, CA), and improved animal husbandry practices. To monitor progress and ensure holistic SI, the program uses the Sustainable Intensification Assessment Framework (SIAF). This framework includes five sustainability domains: (1) productivity, (2) economic, (3) environment, (4) human condition, (5) and social (Musumba et al., 2017[[18]](#footnote-19)).  The adoption of SI technologies is still low among small-scale farmers in Tanzania. Proper targeting of SI innovations is key to increasing these adoption rates (Muthoni et al., 2017[[19]](#footnote-20)). Due to differences in farming systems' bio-physical and socio-economic conditions, each adopted SI innovation will not be equally valuable and lead to improved livelihoods for every Tanzanian household. SI innovations have the potential to solve specific aspects of the farming system, but not others. Furthermore, some system elements are more sensitive, and when improved, the benefits for the farmer households are higher. The FarmDESIGN model will be used to identify which validated SI innovations are more effective for which farming system ‘typology’, which will be identified as positive (PD) and negative (ND) deviants as extremes). FarmDESIGN provides a holistic understanding of the system and its dynamics.  This study aims to understand the gap between Africa RISING -validated SI innovations and successfully adopted SI innovations with high effectivity rates (identify the opportunity spaces for increasing farm performance and resilience). For this purpose, two farm groups will be identified: one with the low-performing farms or negative deviant (ND) farms and the second group with high-performing farms or positive (PD) deviant farms. By comparing the extremes, the opportunity spaces of the two groups will be identified. This leads to the main research question of this study: What are the differences in technology adoption, farm performance, and resilience between positive deviant (PD) and negative deviant (ND) smallholder farms in Tanzania? | | | | | | |
|  | | | | | | |
| 2. Objectives | | | | | | |
| Exploring the sustainable intensification pathways of farming system case studies in Tanzania and assessing the impact of Africa RISING technologies on resilience | | | | | | |
|  | | | | | | |
| 3. Research questions: | | | | | | |
| Main Research question: What are the differences in technology adoption, farm performance, and resilience between positive deviant (PD) and negative deviant (ND) smallholder farms in Tanzania?  Sub questions:   * In terms of SI indicators, which farms perform as ND or PD farms when considering indicators from multiple sustainable intensification domains? (Steps 1 and 2\*) * How do PD farms differ from ND farms regarding adopted SI innovations and structural characteristics? (Steps 3 and 4\*) * What are the differences in opportunity spaces, synergies, and trade-offs among performance indicators of representative ND and PD farms? (Steps 5 and 6\*) * How sensitive are ND and PD farms and their opportunity spaces to declines in maize productivity and increases in input price? (Steps 5a and 6a\*) | | | | | | |
|  | | | | | | |
| 4. Experiment design, implementation, and data analysis: | | | | | | |
|  | | | | | | |
| 5. Data (with metrics) to be collected and uploaded on Dataverse (\* = selected indicators for FarmDESIGN)   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method | | Productivity | | | | | | | Crop grain productivity (maize, pigeonpea, groundnut, vegetables) | kg/ha/season | kg/ha/season | kg/ha/season |  | Yield measurements & Household Survey | | Crop biomass productivity (maize, pigeonpea, groundnut, vegetables) | kg/ha/season | kg/ha/season | kg/ha/season |  | Yield measurements & Household Survey | | Livestock productivity | Animal products (amt./animal/yr.)  Animal by-products (amt./animal/yr.) | Animal product per unit land (amt./ha/yr) Animal byproduct per unit land (amt. /ha /yr) | Animal product per unit land (amt./ha/yr) Animal byproduct per unit land (amt. /ha /yr) |  | Yield measurements & Household Survey | | Variability of production | CV | CV | CV |  | Calculated if multiple year data available | | Dietary Energy Productivity\* | Kcal/ha/season | Kcal/ha/season | Kcal/ha/season |  | Calculated in FarmDESIGN | | Economic | | | | | | | Profitability\* | Net income ($/crop/ha/season)  Gross margin | Net income (total net income for all farm activities)  Gross margin | Net income (total net income for all farm activities)  Gross margin |  | Household survey | | Poverty |  |  | Asset index |  | Household survey | | Labor requirements | Labor requirement (hours/ha) | Labor requirement (hours/ha) | Labor requirement (hours/ha) |  | Household survey | | Market participation |  |  | % production sold |  | Household survey | | Environmental | | | | | | | Soil chemical quality | Soil nutrient levels | Nutrient partial balance |  |  | Soil analysis | | Erosion | Soil loss (tons/ha/yr) |  |  |  | Modeling | | Nitrogen Balance\* | Kg N/ha/season(or yr) | Kg N/ha/season (or yr) | Kg N/ha/season (or yr) |  | Modeled with FarmDESIGN | | OM Balance\* | Kg N/ha/season(or yr) | Kg N/ha/season (or yr) | Kg N/ha/season (or yr) |  | Modeled with FarmDESIGN | | Social | | | | | | | Collective action | Participation in a collective action group | Participation in a collective action group | Participation in a collective action group | Collective action groups | Household survey | | Gender equity | Household decision-making and labor arrangements | Household decision-making and labor arrangements | Household decision-making and labor arrangements |  | Household survey | | Asset ownership distribution\* |  |  | By gender |  | Household survey | | Decision equity distribution or  Asset ownership distribution(-)\* |  |  | * 1. by gender   in case the decision is made, or the asset is owned by a man = 0, together = 0.5, woman = 1. This value is summed for all assets and divided by the number of assets in total. |  | Household survey | | Human | | | | | | | Food security | Food production (Calories/ha/year) | Food production (Calories/ha/year) | Months of food insecurity |  | Calculated & household survey | | Nutrition | Protein production (g/ha) Micronutrient production (g/ha) | Total protein production (g/ha)  Total micronutrient production (g/ha) | Access to nutritious foods |  | Calculated & household survey | | Capacity to experiment |  |  | # of new practices being tested |  | Household survey | | Household Dietary Diversity Score (HDDS)\* |  |  | 0-12 |  | Household survey, FarmDESIGN | | | | | | | |
|  | | | | | | |
| 6. Deliverables | | | Means of verification | | | End date |
| Detailed study design (proposal with research protocol) and data exchanged among team members | | | Email exchanges and weekly online team meetings | | | Jan. 2022 |
| MSc student recruitment | | | Registration with IITA | | | Nov. 2021 |
| Opportunities for improving performance and resilience of smallholder farms in Tanzania assessed with SIAF and FarmDESIGN | | | Report/MSc thesis | | | May 2022 |
| Opportunities for improving performance and resilience of smallholder farms in Tanzania. A comparison of positive and negative deviant farms | | | Draft journal article ready | | | Aug. 2022 |
|  | | | | | | |

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| --- |
| 7. How will scaling be achieved?  This work aims to understand farming systems (positive and negative deviants) and the potential for targeted scaling. |
|  |
| 8. How are the activities in this protocol linked to those of others? This sub-activity is linked to all Africa RISING activities validating and promoting SI interventions in Tanzania. |

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| 9. Gantt chart | | | | | | | | | | | | |
| Year/month | 2021 | | | 2022 | | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Preparation of workplans and study designs with research team, collation, and exchange of existing data |  |  |  |  |  |  |  |  |  |  |  |  |
| (Online) meetings with team members and development of detailed research protocol (proposal) |  |  |  |  |  |  |  |  |  |  |  |  |
| Data processing, analysis & modeling with FarmDESIGN |  |  |  |  |  |  |  |  |  |  |  |  |
| Preparation of reports and publications |  |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets | | | | | |
| a. Output 1.1 | | Demand-driven, climate-smart, integrated crop-livestock research products (contextualized technologies) for improved productivity, diversified diets, and higher-income piloted for specific typologies in target agro-ecologies and scaled in Outcomes 4 and 5 | | | |
| b. Activity: 1.1.2 | | Evaluate and implement pathways that are effective at improving access to seeds and clonal materials of modern varieties of legumes, cereals, vegetables, forages, and livestock | | | |
| c. Sub-activity 1.1.2.1 | | Assessment of the benefits of management technologies on performance of improved vegetable varieties (Season 2) | | | |
|  | | | | | |
| d. Research team: | | | | | |
| Name | Institution | | Role | | |
| Rosina Wanyama | WorldVeg | | PIs, research conceptualization, design, and implementation | | |
| Sognigbe N’Danikou | WorldVeg | | Research conceptualization, design, and implementation | | |
| Julius Manda | IITA | | Research conceptualization, design, and implementation | | |
| Ludovic Joly | Iles de Paix (IdP) | | To support the scaling of vegetable technologies and fund nutrition activities in 9 new villages | | |
| Ayesiga Buberwa | Iles de Paix (IdP | | To support the scaling of vegetable technologies and fund nutrition activities in 9 new villages | | |
| Daniel Mgalla | IITA/IFPRI | | M&E support | | |
|  | | | | | |
| e. Student(s): Nil | | | | | |
|  | | | | | |
| f. Location(s): | Eight villages in Karatu District, Tanzania: Kambi ya samba, Bashay, Buger, Gyekrumlambo, Slahhamo, Rhotia Kainam, Chem, Changarawe, plus new nine villages. | | | | |
|  |  | | | | |
| g. Start date | October 2019 | | | | |
|  |  | | | | |
| h. End date | 30 September 2022 | | | | |
|  | | | | | |
| 1. Justification | | | | | |
| Vegetables are valuable sources of energy, micronutrients, and income generation for rural and urban populations. Traditional vegetables are essential for providing micronutrients and are well adapted to local climatic conditions, tolerant to disease infestation, and easier to grow than exotic hybrid vegetable varieties. However, low production per unit area is the major challenge. The declining yield of vegetables results from poor farming practices such as poor-quality seeds, poorly sown and managed seedlings and inadequate application of manures, limited water for production, misuse and abuse of inorganic fertilizers rampant use of pesticides. Improved management (IM) that combines a technological package of good quality improved seed varieties, healthy seedlings, and good agronomic practices (GAPs) can potentially provide pathways out of hunger and poverty. WorldVeg introduced three improved varieties of vegetables: tomato and traditional vegetables (African nightshade and Ethiopian mustard). Although not a traditional vegetable, the tomato was included because of its well-established market and from which farmers can fetch important incomes. The current research is based on the premise that growing improved vegetable varieties should be combined with improved and safer practices to contribute to more diverse, healthier, and balanced diets while also increasing farm household income. Farmers acknowledged and appreciated the benefits of IPM (insect traps, making biopesticides, etc.) and production practices such as line sowing, making of compost manure, fertilizer application, and installing the irrigation system. | | | | | |
|  | | | | | |
| 2. Objectives | | | | | |
| To assess the impact of improved management practices (improved varieties and good agricultural practices) on the yield and profitability of growing different vegetables (e.g., African nightshade, tomato, and Ethiopian mustard). | | | | | |
|  | | | | | |
| 3. Research questions | | | | | |
| What is the impact of improved management practices on vegetable yield and profits? | | | | | |
|  | | | | | |
| 4. Experiment design, implementation, and data analysis | | | | | |
| Not applicable | | | | | |
|  | | | | | |
| 5. Data (with indicators and metrics) to be collected and uploaded on DataVerse | | | | | |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method | | Productivity | | | | | | | Vegetable productivity | kg/ha/season | kg/ha/season | - | Rating of yields | Yield measurement  Farmer evaluation | | Post-harvest loss |  |  | % of harvest lost |  | Direct measurements | | Economic | | | | | | | Profitability | Gross margin ($/crop/ha/ season) | Gross margin ($/crop/ha/season) | Gross margin ($/crop/ha/season) |  | Direct measurements | | Market participation |  |  | % production sold | Total sales | Direct measurements | | Input intensity |  | Input/ha/season | Input/ha/season |  | Direct measurements | | Environmental | | | | | | | Pesticide use | * Active ingredient applied (kg/ha) | * Active ingredient applied (kg/ha) |  |  | Direct measurements | | Pest levels | Pest abundance and  severity by type |  |  |  | Seasonal transects | | Human Condition | | | | | | | Nutrition |  |  | Access to nutritious vegetables (no. of veg. consumed) |  | Survey | |  |  | Amount consumed (g/day) | % of households consuming below minimum | | Social | | | | | | | Gender equity | Rating of technologies by gender | Rating of technologies by gender | Rating of technologies by gender |  | Focus group discussions (FGD) | |  | Market participation by gender | Market participation by gender | Market participation by gender |  | FGD/Survey | | | | | | |
|  | | | | | |
| 6. Deliverables: | | | | Means of verification | Delivery date |
| Data on the impact of improved management practices on vegetable production collected in new villages | | | | Data set (in DataVerse) | Aug. 2022 |
| Draft paper on the impact of improved management practices, yields, and profitability | | | | Journal Manuscript | Aug. 2022 |
| One Farmer field day conducted in generation 2 villages | | | | Farmer field day reports | Jan. 2022 |
| One success/blog story | | | | Success story submitted to Africa RISING Comms | Aug. 2022 |
| Technology label | | | | Submitted to Africa Rising Comms | Mar. 2022 |
|  | | | | | |
| 7. How will scaling be achieved? | | | | | |
| Iles de Paix (IdP), an NGO in Karatu District, will scale the technologies to the 9 generation 2 villages with an estimated membership of 350 households within Karatu District and other regions where they are conducting development activities (see sub-activity 5.2.2.1). | | | | | |
|  | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | |
| Improved vegetable varieties and good agronomic practices for tomato and traditional African vegetables (TAV) are being scaled by IdP (sub-activity 5.2.2.1). | | | | | |

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| 9. Gantt chart | | | | | | | | | | |
| Year/month | 2021 | | 2022 | | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| 1. 1 Field Day |  |  |  |  |  |  |  |  |  |  |
| 2. Development of data collection tools (questionnaire) |  |  |  |  |  |  |  |  |  |  |
| 3. Training of enumerators and pretest |  |  |  |  |  |  |  |  |  |  |
| 4. Household survey |  |  |  |  |  |  |  |  |  |  |
| 5. Data cleaning and analyses |  |  |  |  |  |  |  |  |  |  |
| 6. Drafting and submission of the first manuscript on *the impact of improved management practices on vegetable yield and profitability* |  |  |  |  |  |  |  |  |  |  |
| 7. Submission of a technology label |  |  |  |  |  |  |  |  |  |  |
| 6. Drafting and submission of a success story |  |  |  |  |  |  |  |  |  |  |

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| Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability | | | | | | | | | |
| a. Output 1.3 | | | Tools (including ICT-based) and approaches for disseminating recommendations in relation to above research products, integrated into capacity development [and used in Outcomes 4 and 5] | | | | | | |
| b. Activity 1.3.1 | | | Conduct extrapolation domain analysis based on GIS, agro-ecology, and crop model-generated information to establish the potential of technologies for geographical reach | | | | | | |
| c. Sub-activity 1.3.1.1 | | | Farmer/Extension messaging to scale-out Africa RISING technologies (forage production and use, crop residue processing and use, and feed rations) using MWANGA and engagement of public and private sector partners for ownership of MWANGA | | | | | | |
|  | | | | | | | | | |
| d. Research team | | | | | | | | | |
| Name | | Institution | | Role | | | | | |
| Job Kihara | | Alliance Bioversity CIAT | | PI | | | | | |
| Jonas Julius/ Rose Anael | | MoA | | Arrange and coordinate village-level feedback meetings | | | | | |
| Eveline Massam | | IITA | | Participate in at least 2, and develop a story from, village-level feedback meetings | | | | | |
| Fred Kizito | | IITA | | Provide technical backstopping and support to the team | | | | | |
|  | | | | | | | | | |
| e. Student(s): Nil | | | | | | | | | |
|  | | | | | | | | | |
| f. Location(s) | | Babati and Kongwa District, Tanzania | | | | | | | |
|  | | | | | | | | | |
| g. Start date | | December 2015 | | | | | | | |
|  | | | | | | | | | |
| h. End date | | August 2022 | | | | | | | |
|  | | | | | | | | | |
| 1. Justification | | | | | | | | | |
| Africa RISING has researched how smallholder farmers can improve their agricultural practices from a sustainability point of view. Sharing the research results is important so that farmers know the positive results that may stimulate them to adopt these technologies. The use of ICT (the Mwanga platform) is a good mechanism to deliver these kinds of messages to farmers cheaply on their phones. The message content shared with farmers is shared with extension agents that cover the farmer communities receiving the messages (of which 309 are on agronomy and the rest in livestock and post-harvest technologies), allowing for periodic follow-up and clarification when needed. While Mwanga has been in use reaching about 1,500 farmers, this should be broadened to scale up agronomy and post-harvest insights. In Babati, we will at least double the numbers of farmers currently being reached; i.e., we will review the current farmer list for Mwanga messaging and update it. The update will include reactivating about 200 farmer contacts who received messages in previous seasons but dropped out during the last 1 or 2 seasons.  From a scientific perspective, it is important to understand to what extent the ICT messaging with Mwanga and offline video benefit the farmers and what they think of this service. For this, we will conduct an evaluation study regarding the utilization of Mwanga (SMS only and SMS and Video) among the farmers who have been receiving agronomy and post-harvest-related messages within different periods. At the same time, it is important to understand the kind of support extension agents feel they need to increase their capacity to develop and deliver messages to farmers through the ICT platform.  To allow continuity and sustainability of Mwanga, we will explore the buy-in and interest of the private sector, specifically agro-dealers and input companies (e.g., SeedCo, MERU Agro, and Minjingu fertilizers) to communicate through this platform as a way of marketing their products. If we have a few companies using the platform, this may encourage others to join efforts to enhance the platform's sustainability. We anticipate reaching out to at least two input/development partners with whom we have had good working relations. The idea is to have the private sector use Mwanga while paying for the cost of the messaging service to support its maintenance. This exposure of the Mwanga platform to input sector players will be included as part of the stakeholder forum planned in sub-activity 5.1.2.2 (i.e., no separate budget).  We will hold feedback meetings at the village level for sharing findings of, e.g., soil analyses, productivity influencing GAPS, communication materials that will have been produced (e.g., videos and flyers), printed photos (e.g. of mother trial host farmers while participating in project activities and technology evaluations) to individual farmers, certificates to lead farmers and to extension agents for excellent engagement and contributions to the Africa RISING demonstrations, trials and field days. Farmer data have been obtained in previous years but have seldom been shared with the farmers. | | | | | | | | | |
|  | | | | | | | | | |
| 2. Objectives | | | | | | | | | |
| 2.1 To deliver agronomic and post-harvest messages to 1,500 farmers in Babati and understand farmers' utilization of these messages. | | | | | | | | | |
| 2.2. Engage with the private sector to explore opportunities for sustainability through the use of MWANGA for communicating to farmers at a cost to the private sector. | | | | | | | | | |
|  | | | | | | | | | |
| 3. Research questions | | | | | | | | | |
| 3.1 To what extent are farmers acting on the ICT messages delivered through the Mwanga platform in the Africa RISING sites in Tanzania? | | | | | | | | | |
| 3.2 Who uses what type of messages, and what benefits do farmers perceive they are gaining from this in the context of knowledge, attitude, practices, and aspirations? | | | | | | | | | |
| 3.3. What support is required by extension agents (based on perceptions or experiences) to develop and deliver messages to farmers? | | | | | | | | | |
|  | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | |
| We will review the current names of farmers listed in Mwanga and expand it with farmers that used to receive messages but dropped in the last year or 2. Telephone numbers no longer in service will be removed. Agronomic messages on best practices for managing land, growing crops, and harvesting will be developed. This complements the climate services and market information already provided through Mwanga to the agronomy farmer messaging group. One new agronomic message will be developed every two weeks and shared with the farmers for two consecutive weeks.  A farmer survey will be conducted among farmers receiving the ICT messages (agronomy and post-harvest) to understand how they have used those messages. The survey targets 300 randomly selected respondents, and we will work in partnership with Esoko to co-develop the survey tool and undertake the survey. This impact evaluation study will capture farmers’ sentiments and preferences and will establish whether there is a change in the knowledge, attitude, skills, and aspirations as a result of accessing ICT services (SMS only and SMS and video); hence it will assess the effectiveness of the method for information delivery to smallholder farmers. A short survey will also be conducted among the extension agents to understand their perceptions on improving their effectiveness in message development and providing feedback to farmers.  Village level feedback meetings will be organized (6 meetings in total, in Long, Sabilo, Seloto, Hallu, Riroda, and Ayamango). The meetings will include offline video viewing communicating agronomy best practices. | | | | | | | | | |
|  | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | |
| Domain & *Indicator* | Field/plot level metrics | | | Farm level metrics | Household level metrics | | Community/landscape level metrics | Measurement method | |
| Productivity | | | | | | | | | |
| *Crop productivity* | Maize, beans, pigeonpea, and cowpea productivity (kg/ha/  season) | | |  |  | |  | Farmer evaluation | |
| Economic | | | | | | | | | |
| *Profitability* | Gross margins ($/crop/ha/ season) | | |  | In relation to the market information services received from the ICT platform | |  | Farmer evaluation | |
| Environmental | | | | | | | | | |
| *Fuel availability, soil* | Fuel biomass (kg/ha/season) | | |  |  | |  | Farmer evaluation | |
| Human condition | | | | | | | | | |
| *Nutrition* | Protein production (g/ha) | | |  |  | |  | Farmer evaluation | |
| *Food security* | Food production (calories/ha/year) | | |  | Months of food insecurity; Rating of food security | |  | Farmer evaluation | |
| *Nutrition* |  | | |  | Access to nutritious foods | |  | Farmer evaluation | |
| *Capacity to experiment* |  | | |  | # of new practices being tested | | % of farmers experimenting | Individual farmer survey | |
|  |  | | |  | Decision making as a result of information on climate services | |  | Farmer evaluation | |
| Social | | | | | | | | | |
| *Gender equity* |  | | |  |  | | Rating of technologies by gender | Farmer evaluation | |
|  |  | | |  | Access to information (important when man and woman share phone) | |  | Farmer evaluation | |
|  |  | | |  | Participation in a collective action group (Household) in relation to agronomy, climate services, and market information | |  | Farmer surveys | |
|  | | | | | | | | | |
| 6. Deliverables | | | | | | Means of verification | | | Delivery date |
| 6.1 Analysis of detailed survey for 300 randomly selected farmers about their sentiments, preferences, and whether there is a change in their knowledge, attitude, skills, and aspirations as a result of accessing ICT services | | | | | | draft journal article | | | Aug. 2022 |
| 6.2. Research summary on utilizing ICT tools to share information (agronomic, climatic, and market services) and scale-out Africa RISING technologies in collaboration with strategic partnerships in Tanzania. | | | | | | Technical brief | | | Aug. 2022 |
| 6.3 Reports on village-level feedback and the results delivery meetings (6 meetings, i.e., in Long, Sabilo, Seloto, Hallu, Qash, and Ayamango). Capture the feedback as a story which will include support from Eveline. | | | | | | Progress reports | | | Aug. 2022 |
|  | | | | | | | | | |
| 7. How will scaling be achieved? | | | | | | | | | |
| This activity utilizes the Mwanga ICT platform for communicating agronomic information. Farmers already enlisted in Mwanga and new farmers to be added will receive agronomic messages. The specific exposure of the tool to seed companies and development partners is geared towards establishing interest and potentially ensuring continued use of the ICT platform for communicating findings and good agricultural practices. | | | | | | | | | |
|  | | | | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | | | | |
| The activities are building on activities undertaken in previous years and on Mwanga ICT, a tool developed within Africa RISING. | | | | | | | | | |
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| 9. Gantt chart | | | | | | | | | |
| Year/month | 2021 | 2022 | | | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| 1. Mwanga database update |  |  |  |  |  |  |  |  |  |
| 2. Co-development of Mwanga messages and messaging |  |  |  |  |  |  |  |  |  |
| 3. Survey instrument development |  |  |  |  |  |  |  |  |  |
| 4. Implementation of survey |  |  |  |  |  |  |  |  |  |
| 5. Video content development |  |  |  |  |  |  |  |  |  |
| 6. Village scientific synthesis and feedback meetings |  |  |  |  |  |  |  |  |  |
| 7. Feedback story development (Eveline) |  |  |  |  |  |  |  |  |  |
| 8. Two bi-annual progress report |  |  |  |  |  |  |  |  |  |

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| Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability | | | | | | |
| a. Output: 1.3 | Tools (including ICT-based) and approaches for disseminating recommendations in relation to above research products, integrated in capacity development | | | | | |
| b. Activity: 1.3.1 | Conduct extrapolation domain analysis based on GIS, agro-ecology, and crop model-generated information to establish the potential of technologies for geographical reach | | | | | |
| c. Sub-activity: 1.3.1.2 | Refine regionally relevant extrapolation domain maps for validated conservation agriculture (CA) practices | | | | | |
|  | | | | | | |
| d. Research team | | | | | | |
| Name | | Institution | | Role | | |
| Francis Muthoni | | IITA | | PI, Geo-Spatial Modeling | | |
| Christian Thierfelder | | CIMMYT | | Provide agronomic data on CA technologies | | |
| Mateete Bekunda | | IITA | | Soil Science | | |
| Julius Manda | | IITA | | Economic analysis | | |
| Francis Msangi | | IITA | | Data management | | |
| Tomslav Hengl | | EnvirometriX | | Consultant Machine learning + remote sensing | | |
|  | | | | | | |
| e. Student(s) | | | | | | |
| Name | | Institute | | Degree | Start | End |
| Robin Cramer | | University of Bonn | | M.Sc. | Jul. 2021 | Mar. 2022 |
|  | | | | | | |
| f. Location(s) | | Malawi, Zambia, ESA Region | | | | |
|  | | | | | | |
| g. Start | | September 2018 | | | | |
|  | | | | | | |
| h. End | | September 2022 | | | | |
|  | | | | | | |
| 1. Justification | | | | | | |
| Recent research has demonstrated the benefits of conservation agriculture (CA) practices in improving the sustainability and productivity of farming systems in Zambia and Malawi. However, the adoption rates of CA practices remain low, partly due to poor spatial targeting. Identifying which CA system offers yield and sustainability advantages over conventional tillage practices (CP) at specific locations. The information will help refine the recommendation domains of different CA systems for better spatial targeting. During the 2019-2020 season, extrapolation domains for conservation agriculture practices in maize-based systems in Southern Africa were generated for seasons with below (2005) and above (2017) average precipitation. A machine learning model (ML), based on Random Forests (RF) algorithm and random cross-validation, was applied for spatial predictions of maize yields from CA and CP systems. The model was calibrated with 13 years of on-farm trials, and 29 remote sensing derived grid rasters. The model showed high accuracy (R2 = 0.63, RMSE = 1.3 t/ha). The predictions examined the yield advantages from CA systems during two seasons with below and above season precipitation. The yield advantages from CA systems covered a larger area during drought compared to the wetter season. A manuscript generated from that study was submitted and is currently revised following reviewers’ comments.  New agronomic data was obtained from CIMMYT covering the 2007–2020 growing seasons. These datasets were applied to predict the spatial variability of maize yield for 16 cropping seasons. The study explored the means of improving the ability of the ML model to extrapolate the yields far beyond the trial sites. Recent research pointed out that machine learning models fitted using random cross-validation show a high agreement of predictions at the location of trial sites but may overfit if extrapolated to areas beyond the training samples (Meyer *et al.,* 2019[[20]](#footnote-21); Ploton *et al.,* 2020[[21]](#footnote-22)). They argued that the random cross-validation leads to considerable overfitting and results in models that can reproduce the training data but fail to make spatial predictions. This is partly because they do not account for spatial autocorrelation of trial sites, thus leading to over-optimistic predictions at sample sites. Meyer et al. (2019) showed that for spatio-temporal data, spatial dependencies could cause a misinterpretation of certain predictor variables, making flexible algorithms fail when predicting beyond the location of the training data. During the 2020-2021 planning year, an ensemble of ML models was trained with a spatial-temporal cross-validation procedure to improve the ML model’s ability to predict yields beyond the locations of the trial’s sites (extrapolation). Moreover, feature selections were employed to eliminate variables that do not lead to better spatial predictions of maize yields beyond the trail sites. The newly added on-farm trial data for the 2017 to 2020 seasons was incorporated to improve the training of the maize yield model. Moreover, the extent of experimental plots was digitized from Google Earth and the rotation sequences in the trials matched. The polygons were used to generate training samples at field-scale resolution (30 m) modeling. The robustness of the spatial predictions of maize yields was evaluated using three machine learning algorithms, i.e., the random forest (RF), eXtreme Gradient Boosting (XGboost), and ridge regression (cv glmnet). The ensemble model showed a concordance correlation (CCC) of 0.773, and the temperature and rainfall-related variables had the highest importance. A draft manuscript is in preparation and will be finalized in the 2021-2022 planning period.  The previous ML models were built from tree-based algorithms. Deep learning (DL), an advanced ML approach, has multiple stacked non-linear layers and can transform the raw input data into a higher and more abstract representation at each stacked layer (LeCunet al., 2015[[22]](#footnote-23)). Recent research suggests that DL is a powerful tool for the prediction of crop yields (Cai et al., 2019[[23]](#footnote-24)). Recently Zhang et al. (2021)[[24]](#footnote-25) compared the predictive ability of ML (Least Absolute Shrinkage and Selection Operator (LASSO), Light Gradient Boosting Machine (LightGBM)), and DL (Long Short-Term Memory (LSTM)) algorithms in the prediction of maize in China and reported that the LSTM model outperformed the LightGBM and LASSO. The application of DL is relatively new and rarely evaluated in Africa. We, therefore, plan to apply DL models to predict the maize yields from CA experiments and evaluate the performance of DL against ML. This will be part of the M.Sc. research.  The ML models trained in the previous seasons revealed that climatic variables are key drivers of maize yields in southern Africa. The frequency of droughts in southern Africa is projected to increase due to climate change (Haghtalab et al., 2019[[25]](#footnote-26)), thereby making the CA systems a suitable adaptation measure. However, there is limited knowledge on the magnitude of effect that will arise from climate change and variability in different management practices and agro-ecologies. ML models can be applied as early warning systems that can be used to generate locally appropriate adaptations to increase the productivity and resilience of smallholder farming systems. Therefore, the already validated ML models for predicting maize yields will be applied as a foresight tool to explore the effect of climate change and variability on maize yields from CA and CP tillage practices at field scale. The validated ML models will be applied to evaluate climate change scenarios and variability, e.g., what is the expected yield from CA and CP tillage systems if seasonal rainfall decreases by 10% from the long-term mean? | | | | | | |
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| 2. Objectives | | | | | | |
| Identify the extrapolation domains for conservation agricultural practices in the southern Africa region. | | | | | | |
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| 3. Research questions | | | | | | |
| 3.1 What biophysical and socio-economic factors limit maize yield most in CA systems in Southern Africa? | | | | | | |
| 3.2 Which machine learning algorithm more accurately predicts the spatial variability of maize grain yields in CA systems in the southern Africa region? | | | | | | |
| 3.2 Does spatial cross-validation improve the accuracy of predicting maize grain yield beyond the trial sites? | | | | | | |
| 3.3 Where do different CA systems offer yield advantage over CP systems duration in seasons with below and above-average precipitation? | | | | | | |
| 3.4 Is inter-seasonal variability of maize yield from CA systems lower than in CP systems? | | | | | | |
| 3.5 Does deep learning (DL) models out-perform machine learning (ML) models in predicting maize yields? | | | | | | |
| 3.5 What is the impact of +/- 20% change in seasonal precipitation and temperature regimes on maize yields under CA and CP systems in southern Africa? | | | | | | |
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| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.). | | | | | | |
| This study will utilize data on maize grain yield and GAPs obtained from multi-year and multi-location on-farm trials spanning up to 16 years from the CIMMYT. The CIMMYT CA long-term trial network database contains information on maize grain yields and conservation agriculture (CA) and complementary technologies applied. Data for biophysical and socio-economic predictor variables will be obtained from remote sensing platforms. Spatial variability of maize yield from 7 CP and 13 CA systems will be estimated and compared. The spatial predictions of maize yields will be evaluated using three machine learning algorithms, i.e., the random forest (RF), eXtreme Gradient Boosting (XGboost), ridge regression (cv glmnet), and deep learning algorithms (LSTM, convolutional neural networks (CNN). The model will be parameterized as follows:  Maize-yield [t ha-1] = f[Treatment + Variety + CA period + Soil + Climate + Terrain + VI + XY coordinates +Socioeconomic]  Where: Maize-yield is the maize yield (response), tillage treatments, variety are seeds of 18 different maize cultivars in the treatments (e.g., ‘ZM309’). The CA period is the time since the CA trial was first established in the trial plot. VI represents satellite-derived vegetation indices that are proxies for vegetation productivity.  The trained ML and DL models will be applied to predict the spatial variations of the maize yields. The calibrated ML/DL models will be applied to generate different maps showing the predicted maize yield resulting from combinations of CA and complementary technologies.  A split sample will be applied to separate 70% of samples for training and 30% for testing. A spatial-temporal cross-validation procedure will be applied during model training to ensure training samples are drawn from different blocks when training the ML models. The test samples will be used to evaluate the model’s accuracy based on R2, concordance correlation coefficient (CCC), and the root mean square error (RMSE) derived from comparing the observed and the predicted maize yields. The calibrated model will be used for spatial prediction of seasonal grain yields (2005 - 2020) from CA and CP systems combined with complementary technologies such as cultivars. The per-pixel yield advantage of CA practices will be calculated as the difference between the predicted yield from the CA and CP treatments. The coefficient of variation (CV) of grain yield for the 16 seasons will be used to assess the inter-seasonal variability of yields for different CA systems. This variability will be compared to the CV of precipitation to assess the resilience of CA and CP systems to climate variability.  The most accurate prediction model will be applied for assessments of the impact of climate change on the maize yields from CP and CA systems. The most accurate model will be applied to predict maize yields for CP and CA treatments for scenarios with +/- 20% change in seasonal precipitation and minimum and maximum temperature. | | | | | | |
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| 5. Data to be collected and uploaded on Dataverse | | | Responsibility/Institute | | | |
| 5.1 CA long-term trial network database (already uploaded) | | | Christian Thierfelder – CIMMYT | | | |
| 5.2 Remote sensing data (open source) | | | Francis Muthoni/Francis Msangi – IITA | | | |

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| 6. Milestones | | | |
| Deliverables | | Means of verification | Date |
| 6.1 Maps – Inter-annual maize yields from CA & CP systems | | Report with maps | Jun 2022 |
| 6.2 Maps- Yield advantage of CA system in different seasons | | Report with maps | Jul. 2022 |
| 6.3 Manuscript on random forest prediction of maize yield for dry and wet seasons | | #1 journal article revised and published | Mar. 2022 |
| 6.4 Manuscript on spatiotemporal ensemble modeling and prediction of maize yield at farm-scale (30 m) | | #1 journal article submitted | Apr. 2022 |
| 6.5 R tutorial on ensemble machine learning method for prediction of maize yield produced | | #1 tutorial published in an open-source repository | Jun. 2022 |
| 6.6 Thesis on deep learning prediction of multi-year variability of maize yield in southern Africa | | #1 MSc. thesis submitted | May 2022 |
| 6.7 Manuscript on spatiotemporal ensemble modeling and prediction of maize yield at farm-scale (30 m) | | #1 journal article submitted | Aug. 2022 |
| 6.8 Impact of climate change on maize yields in CP and CA assessed | | Report with maps | Sep. 2022 |
|  | | | |
| 7. Sustainable intensification indicators | | | |
| 7.1 Productivity | Yield, Yield variability | | |
| 7.2 Environmental | NA | | |
| 7.3 Economic | NA | | |
| 7.4 Social | NA | | |
| 7.5 Human | NA | | |
|  | | | | |
| 8. How will scaling be achieved? | | | |
| The produced yield maps will guide the scaling out of validated CA practices and improved maize cultivars to the most suitable niches. These will be disseminated to extension staff and development partners. | | | |
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| 9 How are the activities in this protocol linked to those of others? | | | |
| Sub-Activity 2.2.1.1: Component long term trials on maize/legume intercropping strategies with pigeonpea, lablab, and cowpea | | | |
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| 9. Gantt chart | | | | | | | | | | | | |
| Activity/Month | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Manuscript 1 | | | | | | | | | | | | |
| Revise manuscript on random forests predictions of maize yields |  |  |  |  |  |  |  |  |  |  |  |  |
| Manuscript 2 | | | | | | | | | | | | |
| Plotting graphic visualizations |  |  |  |  |  |  |  |  |  |  |  |  |
| Write-up & submission |  |  |  |  |  |  |  |  |  |  |  |  |
| Design online tutorial on ensemble machine learning for yield prediction |  |  |  |  |  |  |  |  |  |  |  |  |
| Thesis/manuscript 3 | | | | | | | | | | | | |
| Literature review & consultations for deep learning |  |  |  |  |  |  |  |  |  |  |  |  |
| Data processing & preparation |  |  |  |  |  |  |  |  |  |  |  |  |
| Deep learning model training & accuracy assessment |  |  |  |  |  |  |  |  |  |  |  |  |
| Thesis write-up & submission |  |  |  |  |  |  |  |  |  |  |  |  |
| Draft manuscript comparing deep learning and machine learning predictions |  |  |  |  |  |  |  |  |  |  |  |  |
| Foresight impact of climate change |  |  |  |  |  |  |  |  |  |  |  |  |
| Scenario building for the impact of climate change |  |  |  |  |  |  |  |  |  |  |  |  |
| Maps & report writing on projected impacts of climate change on maize yields |  |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability | | | | | |
| a. Output: 1.3 | Tools (including ICT-based) and approaches for disseminating recommendations in relation to above research products, integrated with capacity development | | | | |
| b. Activity: 1.3.1 | Conduct extrapolation domain analysis based on GIS, agro-ecology, and crop model-generated information to establish the potential of technologies for geographical reach | | | | |
| c. Sub-activity: 1.3.1.3 | Produce regionally relevant extrapolation domain maps for validated soil and water conservation practices | | | | |
|  | | | | | |
| d. Research team | | | | | |
| Name | Institution | | Role | | |
| Francis Muthoni | IITA | | PI | | |
| Anthony Kimaro | ICRAF | | Provide technologies and their validation data | | |
| Elirehema Swai | TARI-Makutupora | | Provide technologies and their validation data | | |
| Shitindi Mawazo | SUA | | Provide technologies and their validation data | | |
| Jonathan Reith/Olena Dubovyk | Bonn University | | Model land degradation risk | | |
|  | | | | | |
| e. Student(s): Nil | | | | | |
|  |  | | | | |
| f. Location(s) | Tanzania - Kongwa & Kiteto Districts | | | | |
|  |  | | | | |
| g. Start | September 2018 | | | | |
|  |  | | | | |
| h. End | September 2021 | | | | |
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| 1. Justification | | | | | |
| Sustainable intensification technologies are suited to specific biophysical and socio-economic contexts. Technologies validated at a location should be suitable for scaling to other locations with similar biophysical and socio-economic contexts. Identifying areas with relatively similar conditions or outcomes to that observed in technology trial sites is one of the essential components of successful scaling out. Biophysical conditions or yields obtained from trial sites with good performance of technological packages will be used as a reference for mapping other potentially suitable locations in the ESA region. During the 2019-2020 season, research was undertaken to map land degradation hotspots using remote sensing data in Tanzania's Kongwa and Kiteto districts. The trends of land productivity, land cover, and soil organic carbon were used as a proxy for land degradation, a field assessment of the types and magnitude of land degradation, and sustainable land management practices in the Kongwa district. The study developed a method of monitoring land degradation at sub-national scales that used high spatial resolution remote sensing data to identify subtle changes in land productivity in an area dominated by small-scale farms. Hotspots for land degradation in the Kongwa and Kiteto districts of Tanzania were identified that could be prioritized for targeting soil and water conservation practices to reverse the land degradation trend. A manuscript was published focusing on local-scale assessment of land degradation (Reith et al., 2021[[26]](#footnote-27)).  Moreover, during the 2020-2021 planning season, a remote sensing-based regional analysis of land degradation of the East and Southern Africa (ESA) region (Tanzania, Malawi, and Zambia) was undertaken to expand results obtained from local-scale analysis in the Kongwa and Kiteto districts. This study applied the Normalized Vegetation Index (NDVI), which is a surrogate for vegetation productivity, to investigate (1) the degree of change in productivity over East and South Africa (ESA region) over the past three decades (1983 - 2015) and (2) quantify the relative importance of climatic and human disturbance factors on the NDVI trends. A draft manuscript is available and will be further prepared for submission to a journal. | | | | | |
|  | | | | | |
| 2. Objectives | | | | | |
| 2.1 Identify where in the ESA region the validated technological packages can be extrapolated with the lowest potential risk of failure. | | | | | |
|  | | | | | |
| 3. Research questions | | | | | |
| 3.1 What is the rate of change in vegetation productivity in East and South Africa (ESA region) over the past three decades? | | | | | |
| 3.2 What is the relative importance of climatic and human disturbance factors in explaining the trend of land productivity (NDVI) over the East and Southern Africa (ESA) region? | | | | | |
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| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.). | | | | | |
| The regional analysis focused on three countries in the East and South Africa (ESA) region; Tanzania, Malawi, and Zambia. The analysis utilized the Global Inventory Modeling and Mapping Studies (GIMMS2)- Normalized Difference Vegetation Index third generation (NDVI3g) data which was generated by the National Aeronautics and Space Administration (NASA) (Pinzon and Tucker, 2014[[27]](#footnote-28)). NDVI3g is a satellite-derived proxy of vegetation productivity. A 33 years time-series of seasonally aggregated NDVI (iNDVI) was utilized to monitor the vegetation productivity trend. Gridded rainfall data with 4 Km spatial resolution was obtained from the TerraClimate database (Abatzoglou et al., 2018[[28]](#footnote-29)). The Residual Trend analysis (RESTREND) method was applied, by examining the trend of residual seasonally aggregated NDVI and rainfall. A classification scheme proposed by (Leroux et al.,[[29]](#footnote-30) (2017) was adopted to disentangle the effect of rainfall from other factors (including anthropogenic disturbances) in driving the trend of the iNDVI. | | | | | |
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| 5. Data to be collected and uploaded | | | | Responsibility/Institute | |
| No data collection is planned, only the write-up of the manuscript | | | |  | |
|  | | | | | |
| 6. Milestones | | | | | |
| Deliverables | | Means of verification | | | Date |
| 6.1 Publication on land degradation neutrality | | #1 journal article published | | | Sep. 2022 |
|  | | | | | |
| 7. Sustainable intensification indicators: NA | | | | | |
|  | | | | | |
| 8. How will scaling be achieved? | | | | | |
| The land degradation index (LDI) map will guide spatial targeting of soil and water conservation practices in the ESA region | | | | | |
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| 9 How are the activities in this protocol linked to those of others? | | | | | |
| Sub-activity 2.1.1.4 - Land rehabilitation through the integration of fodder trees and grass forage species in dryland farming  Sub-activity 1.1.1.5 - Determining the productivity and resilience benefits of Gliricidia-based cropping systems  Sub-activity 2.2.1.5 - Evaluation of land rehabilitation benefits of shelterbelts and contours  Sub-activity 2.2.1.7 - Demonstrate technologies on soil and water conservation for enhancing resilient to climate change in semi-arid agro-ecologies of Central Tanzania | | | | | |

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| 9. Gantt chart | | | | | | | | | | | | |
| Activity/Month | 2021 | | | 2022 | | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Finalize manuscript write-up & submission |  |  |  |  |  |  |  |  |  |  |  |  |

Outcome 2: Natural resource integrity and resilience to climate change enhanced for the target communities and agro-ecologies

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| Outcome 2: Natural resource integrity and resilience to climate change enhanced for the target communities and agro-ecologies | | | | | | | | |
| a. Output 2.1 | | Demand-driven research products for enhancing soil, land and water resources management to reduce household/community vulnerability and land degradation piloted in priority agro-ecologies | | | | | | |
| b. Activity 2.1.1 | | Characterize current practices in ESA through identifying formal and informal arrangements for access to and use of water and land resources | | | | | | |
| c. Sub-activity 2.1.1.1 | | Assessing buffer and adaptive capacity to harness resilience of different farm types | | | | | | |
|  | | | | | | | | |
| d. Research team | | | | | | | | |
| Name | | | | Institution | | Role | | |
| Jeroen Groot | | | | WUR | | Activity coordinator | | |
|  | | | | | | | | |
| e. Student(s): Nil | | | | | | | | |
|  | | | | | | | | |
| f. Location | Babati, Tanzania | | | | | | | |
|  | | | | | | | | |
| g. Start | 1 October 2019 | | | | | | | |
|  | | | | | | | | |
| h. End | 1 July 2022 | | | | | | | |
|  | | | | | | | | |
| 1. Justification | | | | | | | | |
| Vulnerability and resilience are two crucial attributes of smallholder farming systems that can be used for analyzing the response to disturbances. We will assess these properties in relation to the buffer and adaptive capacity, which depend on the ‘window of opportunities’ of possible changes in productive, socio-economic, and environmental performance indicators, i.e., the ‘solution space’. The system's vulnerability can be quantified as the distance of selected performance indicators between original and disturbed systems. The buffer capacity will be derived from the size of the solution space that could be obtained after reconfiguration of farm components (crops, animals, fertilizers, etc.) that were present on the original farm, whereas the assessment of adaptive capacity was derived similarly but after allowing innovation by introducing new components to the farm. These features will be different for the various farm types in Babati (Tanzania) since they depend on the context (biophysical and socio-economic) and the resources and activities of farms and households. Below we describe the conceptual basis. The activity builds on existing farm and household structure datasets and farming (from surveys such as ARBES) practices and the proposed and tested Africa RISING technologies (from project scientists).  Conceptual basis  A disturbance can be a pest, a drought, or a product price decline that negatively affects the farming system's performance. The farmer can prepare for or respond to a disturbance by reconfiguring the farm with changes in crop areas, animal numbers, amounts of inputs, selected market channels, or management practices to compensate for the effect of the disturbance. The available options for adjusting the system with existing components and resources can be considered the ‘buffer capacity’. When the farmer decides to introduce new crops, animals, inputs, or practices, the required adjustment and reconfiguration (both in the ecological system and in farm management) is expected to be considerably larger than the buffer capacity and is reflected in the ‘adaptive capacity’. This illustration of the concepts for an agroecosystem demonstrates that besides the ecological (self-)organization, the farmer, his flexibility and skills, and cognitive and managerial capacities will determine the chosen strategy of adaptation and the final effectiveness of reconfiguration, and thus agroecosystem resilience.  All possible combinations of values of performance indicators constitute the ‘window of opportunities’ or ‘solution space’ for a particular system. The potential of a system (P), resulting from the buffer and adaptive capacity, can be derived from the size of the solution space, which defines the options for adjustment of the system. The solution space is delimited by the Pareto frontier (or Pareto surface when more than two performance criteria are included in the analysis), and for the assessment of resilience, we consider only options that perform at least as good as the existing system. The Pareto frontier can be established using multi-objective optimization, and the area (in 2 dimensions), volume (3 dimensions), or hyper volume (>3 dimensions) of the solution space can be calculated, for instance, relative to a given reference point that represents the existing situation.  This is demonstrated in Figure 1, wherein only the portion of the solution space with improvements in two system indicators (productivity and environmental quality in this case) relative to the existing situation after a disturbance is depicted. The buffer capacity (area B in Figure 1a) is estimated as the solution area corresponding to the reconfiguration of links and flows among the components that are already in the system. The adaptive capacity (area A in Figure 1a) is estimated as the expansion of the solution area when new components are introduced into the system. The potential (P) is estimated as the sum of areas A and B.  Macintosh HD:Users:jeroengroot:Dropbox:Artikelen:027 Resilience:Submitted ES:Figure 1.gif  Figure 1. Portions of solution spaces with future options that perform better for two generic objectives, productivity and environmental quality, relative to disturbed states denoted by red symbols. (a) After a disturbance, the system states change following the arrow from point 1 to point 2 (vulnerability v is the distance between points 1 and 2) and move to a more desirable state such as point 3 (resilience r is the distance between points 2 and 3). Area A represents the adaptive capacity, and B the buffer capacity of the system after the disturbance. Potential P is calculated are the sum of areas A and B. White symbols denote alternatives for the current system. (b) The potential of a system at consecutive moments in time, with changing attained states (points 1, 3, 5, and 7) and after disturbances (points 2, 4, and 6). | | | | | | | | |
|  | | | | | | | | |
| 2. Objectives | | | | | | | | |
| * 2.1 Analyze input-output relations for farm production activities (cropping, animal husbandry, etc.) * 2.2 Quantify potential effects of disturbances on-farm production activities for multiple performance indicators. * 2.3 Model farm/household level effects of disturbances to assess vulnerability for different farm types * 2.4 Quantify the buffer and adaptive capacity of farms and households of different types * 2.5 Establish pathways to harness farm and household resilience for different farm types | | | | | | | | |
|  | | | | | | | | |
| 3. Research questions | | | | | | | | |
| 3.1 To what extent are productive, socio-economic, and environmental performance indicators at the farm and household level affected by biophysical and socio-economic disturbances (e.g., drought, price fluctuation | | | | | | | | |
| 3.2 What are the buffer and adaptive capacity of different farm and household types for disturbances in selected productive, socio-economic, and environmental performance indicators? | | | | | | | | |
| 3.3 Which efficient pathways for performance improvement can be used to recover after disturbances by different types of farms or households? | | | | | | | | |
|  | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | |
| * FarmDESIGN modeling using existing parameterized farms/households for three farm types per region * Inventory of production activities that are used on farms or tested by the project (technologies), these production activities (inputs and outputs) are added to the farm models as input data but can also be used to validate the models * Individual discussions and focus group discussions with farmers and experts to assess the feasibility of changes pathways to harness resilience * Surveys, focus group discussions, farming systems modeling, and a serious game. | | | | | | | | |
|  | | | | | | | | |
| 5. Data (with metrics) to be collected and uploaded on Dataverse | | | | | | | | |
| Domain | | | Indicator | | | | Metrics and scale | |
| Non-domain | | | Parameterized model for various farm types per region | | | |  | |
| Productivity | | | Crop productivity | | | | Crops yield (kg/ha/year) under regular and disturbed conditions (at field and farm levels) | |
|  | | | Animal productivity | | | | Animal products (kg/animal/year) under regular and disturbed conditions (at animal and farm levels) | |
|  | | | Input use efficiency | | | | Product per input (at field, herd, and farm levels) | |
| Economic | | | Profitability | | | | Gross margin of crop and animal operations and operating profit of farm operation (USD) | |
|  | | | Labor requirement | | | | Labor requirements at field, animal, herd, farm, and household levels | |
| Environment | | | Soil chemical quality | | | | Carbon and nutrient (N, P, K) budgets, losses to air and soil (at field and farm levels) | |
| Human condition | | | Nutrition | | | | Nutrient production (kg/year) at field and farm levels; Dietary Diversity (using Nutritional functional Diversity/Dispersion) | |
|  | | | Food security | | | | Food production (kcal/year) at field and farm levels. Food accessibility | |
|  | | | Capacity to experiment | | | | Willingness to implement a new farm configuration after disturbance | |
| Social | | | Equity | | | | Rating of farm configurations per group and agency (leadership roles) | |
|  | | | | | | | | |
| 6. Deliverables | | | | | Means of verification | | | Delivery date |
| 6.1 Journal article submitted | | | | | PDF of submitted papers | | | 30 Jun. 2022 |
| 6.2 MSc thesis/ student report | | | | | PDF of reports | | | 30 Jun. 2022 |
| 6.3 Research data generated | | | | | Data uploaded in Dataverse | | | 30 Jun. 2022 |
|  | | | | | | | | |
| 7. How will scaling be achieved? | | | | | | | | |
| Our assessment builds upon a locally validated yet general inter- and intra-household diversity pattern. Since our case study households have been selected as representative of farm types of different resource endowments, we expect our findings to be relevant to most other farms of the same type. We envision testing the transferability of our results through Focus Group Discussions and individual consultations beyond the current case study site to ensure greater validity). Our findings mean to guide Africa RISING’s scaling effort by revealing how the resilience of the different farm and farmer types can be improved best by which of the Africa RISING technologies. | | | | | | | | |
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| 8. How are the activities in this protocol linked to those of others? | | | | | | | | |
| The modeling exercise builds on past and ongoing Africa RISING trial data, i.e., data from the on-farm experiments and the farmer-led baby- and upscaled trials. The models will be updated, extended, and tested in close collaboration with the Africa RISING-regional coordinators and other project experts in Arusha. | | | | | | | | |
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| 9. Gantt chart |  | | |  | | | | | |
| Year/month | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June |
| Analysis |  |  |  |  |  |  |  |  |  |
| Write report |  |  |  |  |  |  |  |  |  |
| Write article |  |  |  |  |  |  |  |  |  |
| Submit data |  |  |  |  |  |  |  |  |  |

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| Outcome 2: Natural resource integrity and resilience to climate change enhanced for the target communities and agro-ecologies | | | | |
| a. Output 2.2 | Innovative options for soil, land and water management in selected farming systems demonstrated at strategically located learning sites | | | |
| b. Activity 2.2.1 | Set up demonstration and learning sites in target ESA communities | | | |
| c. Sub-activity 2.2.1.2 | Investigations on nutrient and water management for climate resilience along a climate gradient in southern Malawi | | | |
|  | | | | |
| d. Research team | | | | |
| Name | Institution | Role | | |
| Regis Chikowo | MSU | PI, lead overall work | | |
| Sieg Snapp | MSU | Support PI | | |
| Innocencia John | MSU | Economic analysis | | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s) | Mtubwi, Nsanama, Nyambi, Extension Planning Areas (EPAs) | | | |
|  |  | | | |
| g. Start date | October 2016 | | | |
|  |  | | | |
| h. End date | July 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| Experiments on nutrient and water management were carried out in southern Malawi where there is a high risk of droughts. Although these trials have now been terminated, they have generated useful data to inform how ‘Climate Smart’ it is to capture more rainfall water through tied ridging. We used the trials to consolidate action learning with farming communities hugely exposed to high seasonal rainfall variability, often making fertilizer investments unattractive. Therefore, simple approaches, such as tied ridges, that buffer farmers against soil moisture stresses were promoted. These in-situ rainwater storage practices increase residence time for rainwater to infiltrate, as tropical storms often have rainfall intensity that exceeds soil water infiltration several times. We have facilitated mainly the institutionalization of approaches that enhance resilience within the Malawi extension services, as these trials were used by extension as climate-smart interventions field day platforms.  Achievement against output: During drought years, our research has shown significant productivity gains in crops and better fertilizer use efficiencies. We have seen consistent increases of at least 300 kg/ha when water management is superimposed on nutrient management. We estimate that 10% of the farmers are already integrating tied ridges on portions of their farms, especially in drought-prone areas of the Machinga district. This work underpins the building of resilience under variable rainfall conditions.  COVID-19 disrupted our planned focus group discussions in 2021. In 2022, we will seek to answer the question – if results from experiments are almost always positive, and farmers report little extra labor requirement with tied ridges, why is this technology not widely adopted by most farmers, especially in drought-prone regions. The feedback from farmer groups will be built in during the development of a Climate Smart Rainwater- harvesting Africa RISING legacy document/policy brief. | | | | |
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| 1. Objectives | | | | |
| * 1. To prepare a manuscript on ‘beating rainfall variability related stressors in semi-arid Malawi’   2. To prepare a policy brief based on Africa RISING climate-smart interventions experiences, and other dissemination materials for extension and informing policy | | | | |
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| 3. Research questions | | | | |
| * 3.1 What are the impediments to the wide-scale adoption of tied ridges as a water conservation measure in the drought-prone Machinga district? | | | | |
| * 3.2 Does in-situ water harvesting through tied ridges result in better nutrient and water use efficiencies across sites and rainfall seasons? | | | | |
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| 1. Experiment design, implementation, and data analysis | | | | |
| No new field trials will be implemented. However, to put context to the available data, we implemented trials in the Machinga district that investigated the interactions between rainfall received, nutrient management, and soil type for several years. The main plot factor was water management (tied or no-tied ridges), while sub-plots factors were NP management and cropping sequencing: 1) continuous non-fertilized maize, 2) maize fertilized at 35 or 70 kg N ha-1 [N-35 or N-70], 3) sole groundnut or a groundnut/pigeonpea intercrop, both sequenced with maize in Years 2 and 3.   1. Maize– control 2. Maize – control with tied ridges (with TR) 3. Maize + fertilizer (full rate NP) (continuous maize every year) 4. Maize + fertilizer (full rate NP) with TR (continuous maize every year) 5. Maize + fertilizer (half rate NP) following groundnut +TR 6. Maize + fertilizer (half rate NP) following groundnut +TR 7. Maize following groundnut + pigeonpea 8. Maize following groundnut + pigeonpea with TR 9. Maize + fertilizer (half rate NP) 10. Maize + fertilizer (half rate NP) with TR   Tied ridges management:   * Tied ridges were made at planting time to capture as much rainwater as possible * Flexible ridge management – ridge ties were broken during flooding periods (when there were continuous rains for over seven days) | | | | |
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| 1. Data (with metrics) to be collected and uploaded on Dataverse | | | | |
| No new field data on productivity will be collected. However, further analysis will be done based on available data. Focus group discussion will tease out the major impediments to broader adoption of climate-smart practices such as tied ridges.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method | Responsible | | Productivity | | | | | | MSU | |  |  |  |  |  |  | MSU | | Economic | | | | | | MSU | | *Labor requirement* |  |  | Farmer rating of labor |  | Farmer evaluation | MSU | | Environmental | | | | | |  | | *Water availability* | % of plants wilting |  |  |  | Survey; participatory  exercise |  | | *Erosion* | Rating of soil erosion |  |  |  | Participatory exercise |  | | Human condition |  |  |  |  |  |  | | *Nutrition* | Protein production (g/ha) |  |  |  | Lookup tables | MSU | | Social | | | | | | MSU | | *Gender equity* | Rating of technologies by gender |  |  |  | Participatory evaluation | MSU | | | | | |
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| 6. Deliverables | | | Means of verification | Delivery date |
| 6.1 Soil water and nutrients use interactions documented | | | Policy brief and manuscript prepared | Jul. 2022 |
| 6.2. Participate in climate-smart policy platforms and country-level policy dialogue | | | At least one workshop attended/ presentation made (Mwapata) | Aug. 2022 |
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| 7. How will scaling be achieved? | | | | |
| Malawi extension system mainstreaming Climate-Smart interventions in different districts. | | | | |
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| 8. How are the activities in this protocol linked to those of others? | | | | |
| CIMMYT uses CA to increase soil water availability to improve crop productivity (Sub-activity 5.1.1.1). This objective is core to this sub-activity. | | | | |

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| 9. Gantt chart | | | | | | | | | | | |
| Year/monthActivity | 2021 | | 2022 | | | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Data synthesis and write up |  |  |  |  |  |  |  |  |  |  |  |
| Farmer focus group workshops/feedback meetings |  |  |  |  |  |  |  |  |  |  |  |
| Report writing/publications |  |  |  |  |  |  |  |  |  |  |  |
| DataVerse data upload |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 2: Natural resource integrity and resilience to climate change enhanced for the target communities and agro-ecologies | | | | |
| a. Output 2.2 | Innovative options for soil, land, and water management in selected farming systems demonstrated at strategically located learning sites [and scaled in Outcome 5] | | | |
| b. Activity 2.2.1 | Set up demonstration and learning sites in target ESA communities | | | |
| c. Sub-activity 2.2.1.6 | Validation of residual tied ridging as a labor-saving technology in semi-arid areas of central Tanzania | | | |
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| d. Research team | | | | |
| Name | Institution | | Role | |
| Elirehema Swai | TARI Makutupora | | PI – Overall coordination and production of a manuscript on crop and soil water variables | |
| Lutengano Edward Mwinuka | University of Dodoma | | Data analysis and preparation of the economic section of the manuscript | |
| Emanuel Mbazi Msemo | SUA | | Providing expertise in long term data analysis | |
| Julius Manda | IITA | | Providing technical backstopping on the economic section of the manuscript | |
| Gundula Fischer | IITA | | Preparation of the gender section of the manuscript | |
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| e. Student(s): Nil | | | | |
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| f. Location(s) | Laikala, Mlali, Ngumbi and Sagara villages in Kongwa District | | | |
|  | | | | |
| g. Start date | September 2016 | | | |
|  | | | | |
| h. End date | September 2022 | | | |
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| 1. Justification | | | | |
| Introducing and popularizing technologies to reduce drudgery for rural overburdened resource-constrained farming communities is important. Over the 2018-2019 and 2019-2020 cropping seasons, information on sustainable intensification (SI) domains has been collected, focusing on labor requirements under in situ rainwater harvesting (IRWH) technologies, notably annual and residual tied ridging. Similarly, information on economics and productivity has been collected. It has been noted that a knowledge gap exists related to the efficacy of IRWH; knowledge on the efficacy of tied ridges (annually made ridges (ATR) and residual tied ridges (RTR)) in addressing the challenge of recurrent drought associated with the impact of climate change and variability is limited.  During the 2019-2020 and 2020-2021 cropping seasons, the study on the use of rainout shelters to induce water stress for assessing the efficacy of in situ rainwater harvesting methods on soil water status and crop performance in semi-arid areas of Central Tanzania was undertaken at Mlali village, Kongwa district. In this study, a drought condition was imposed at the flowering stage using the exclusion rainout shelter technique to mimic intra-seasonal droughts, which normally occur in the central region of Tanzania. So far, data have been collected from both ambient rainfall conditions and imposed drought condition treatments to generate data that will be used for quantifying the efficacy of the technology. This study cannot be accomplished without a comprehensive understanding of the spatial-temporal variability of rainfall. Because of these, during the 2021-2022 cropping season, long-term rainfall data of not less than 30 years will be sourced from Tanzania Livestock Research Institute (TALIRI). Subsequently, different experts will be consulted on appropriate simulation models that will be applied in analyzing long-term daily rainfall data. This information will be employed during the preparation of the manuscript. | | | | |
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| 2. Objectives | | | | |
| 2.1 To compare the effects of residual tied ridges, annually made tied ridges, and conventional farmer practice in addressing the challenge of drought during the cropping season. | | | | |
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| 3. Research question | | | | |
| 3.1 Which IRWH technology effectively addresses the challenge of drought in the semi-arid areas of central Tanzania? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| Experiment design, implementation, and data analysis  4.1. Use of rainout shelters to induce water stress for assessing the efficacy of in situ rainwater harvesting methods on soil water status and crop performance in semi-arid areas of Central Tanzania.  The induced drought stress experiment initiated at Mlali village, Kongwa District, during the 2019-2020 cropping season will continue during the 2021-2022 cropping season. The rainout shelter will be installed in all treatments simultaneously at the flowering stage. Rainout shelters will cover an area of 3m x 3m, will have a height of 2.4 m to 3.4 m, and a roof inclination of 18° for precipitation runoff (see research protocol, figure 2e). The rainout shelter will exclude all the ambient rainfall (i.e., 100%) to establish how long a crop can survive under the different treatments.  The field trial is arranged in a split-plot design with three replications. The treatments consist of three tillage methods, notably conventional tillage, and two IRWH, notably annual tied ridges (ATR) and residual tied ridge (RTR), and two improved maize varieties, namely commercial maize variety (i.e., DKC9089) and drought-tolerant maize (i.e., WE2109) thus giving a total of six treatment combinations.  Data to be collected  Long-term rainfall data: During the 2021/2022 fiscal year, long-term rainfall data for the Kongwa district will be sourced from Tanzania National Pasture Research Institute (TALRI) and Tanzania Meteorological Authority.  4.2 Preparation of manuscript on the use of rainout shelters on imposed drought: Data collected during the 2019/2020 cropping season to the 2020/2021 cropping season will be analyzed. A statistician, as well as subject matter specialists, will be consulted. Finally, a manuscript will be prepared. Key disciplines, notably weather and climate experts, agronomist, plant breeder, and a statistician, will be engaged for two months consecutively.  Data analysis   * Analysis of long-term rainfall data. Climate experts from the Tanzania meteorological Authority (TMA), Research Institutions, and universities will be consulted on a statistical rainfall model to draw an inference. * Biophysical variables: Analysis of variance for biophysical variables collected during 2019/2020 to 2020/2021 cropping seasons, namely crop growth/yield, hydrological and physical variables, will be run using Genstat software. * Food security: Food security parameters will be estimated by converting maize grain yield per hectare in all treatments to calories produced per hectare using published constant conversion factors of dry grain weight to calories and protein specific to Tanzania (Lukmanji et al., 2008[[30]](#footnote-31)). * Economic analysis: To quantify the profitability of using in situ rainwater harvesting technologies, the Gross margin ($/ha) method will be used. | | | | |
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| 5. Data to be collected and uploaded on DataVerse for 4.1 | | | | |
| |  |  |  | | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Measurement method | | Productivity | | | | *Crop (maize) productivity* | Maize grain yield (kg/ha/season) | Yield measurements | | *Crop biomass productivity* | Stover production (kg/ha/season | Yield measurements | | Environmental | | | | *Water availability* | Soil moisture content (%) | Field tests | | Economics | | | | *Profitability* | Gross margin ($/ha) | Participatoryevaluation | | Human condition | | | | *Foodsecurity* | Food production (calories/ha/year; Protein g/ha/year) | Lookup tables | | | | | |
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| 6. Deliverables | | Means of verification | | Delivery date |
| 6.1 First draft of manuscript on the use of rainout shelters to induce water stress | | Manuscript shared with co-authors and CS | | Feb. 2022 |
| 6.2 Incorporation of comments received from internal reviewers | | Confirmation of submission of the manuscript from journal | | Mar. 2022 |
| 6.3 Submission of manuscript to journal | | Acknowledgment from recipient journal | | Apr. 2022 |
| 6.4 Edit peer-reviewed manuscript | | Final submission to journal | | Jun. 2022 |
| 6.5 Technology label | | Submission to CS | | Mar. 2022 |
| 6.6 Weather data submitted to Dataverse | | Data Uploaded on Dataverse | | Aug. 2022 |

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| 7. How will scaling be achieved? |
| The DAICO for Kongwa will be consulted during the 2021-2022 cropping season to put in place modalities for engaging extension officers in Africa RISING action sites, i.e., Mlali, Nghumbi, Laikala, and Sagara villages. Similarly, farmers’ field days (FFDs) are an important platform to showcase best practices. The FFDs will engage farming communities in the project area as well as neighboring villages to improve decision-making about in-situ rainwater harvesting technologies. |
|  |
| 8. How are the activities in this protocol linked to those of others? |
| The in-situ rainwater harvesting technology is being validated with activity 1.2.2.2: Gender analysis of soil and water conservation technologies and 5.1.3-IITA on identifying and communicating gender-sensitive decision support technology in different farm typologies. It is linked to sub-activity 1.1.1.7- SUA/IITA on monitoring the impact of weather and climate variability. Assess the effect of tied ridging, residual tied, and rip tillage on maize productivity, net crop returns, household income, and food security. |

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| 10. How are the activities in this protocol linked to those of others? |
| The in-situ rainwater harvesting technology is being validated with activity 5.1.3.3 SUA on assessing the integrative effect of in-situ rainwater harvesting and fertilizer micro-dosing on crop yield, water, and nutrient use efficiency in technology Kongwa District. It is linked to sub-activity 4.1.1.4 Assess the effect of tied ridging, residual tied and rip tillage on maize productivity, net crop returns, household income, and food security. It is also linked to Sub-activity 1.2.2.2: Gender analysis of soil and water conservation technologies. |

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| 9. Gantt chart | 2021 | | 2022 | | | | | | | | |
| Activity/ month | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Rainfall data collection |  |  |  |  |  |  |  |  |  |  |  |
| Data collection from weather stations |  |  |  |  |  |  |  |  |  |  |  |
| Data entry and quality control |  |  |  |  |  |  |  |  |  |  |  |
| Consultation of experts on a statistical model for simulation of rainfall data |  |  |  |  |  |  |  |  |  |  |  |
| Retreat while on preparation of manuscript |  |  |  |  |  |  |  |  |  |  |  |
| Drafting of manuscript on rainout shelter |  |  |  |  |  |  |  |  |  |  |  |
| Internal review of rainout shelter manuscript |  |  |  |  |  |  |  |  |  |  |  |
| Incorporation of comments into manuscript |  |  |  |  |  |  |  |  |  |  |  |
| Submission of manuscript to journal |  |  |  |  |  |  |  |  |  |  |  |
| Uploading of rainfall data into Dataverse |  |  |  |  |  |  |  |  |  |  |  |

Outcome 3: Food and feed safety, nutritional quality, and income security of target smallholder families improved equitably

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| Outcome 3: Food and feed safety, nutritional quality, and income security of target smallholder families improved equitably (within households) | | | | | |
| a. Output 3.1 | Demand-driven research products to reduce postharvest losses and improve food quality and safety piloted in target areas [and scaled in Outcome 5] | | | | |
| b. Activity 3.1.1: | Conduct packaging and delivery of postharvest technologies through community and development partnerships with iterative review, refining, and follow-up | | | | |
| c. Sub-activity 3.1.1.1 | Assess the impact of nutrition intervention on farmers' nutritional knowledge, attitude and practices, and household nutrition status in partnership with Islands of Peace (generation 1 villages) | | | | |
|  | | | | | |
| d. Research team: | | | | | |
| Name | | Institution | Role | | |
| Rosina Wanyama | | WorldVeg | PI, research conceptualization, design, and implementation | | |
| Sognigbe N’Danikou | | WorldVeg | Research conceptualization, design, and implementation | | |
| Julius Manda | | IITA | Research conceptualization, design, and implementation | | |
| Ludovic Joly | | Iles de Paix (IdP) | Fund and participate in nutrition training | | |
| Ayesiga Buberwa | | Iles de Paix (IdP) | Fund and participate in nutrition training | | |
| Daniel Mgalla | | IITA | M&E Support | | |
|  | | | | | |
| e. Student(s): Nil | | | | | |
|  | | | | | |
| f. Locations: | | 8 villages in Karatu: Kambi ya samba, Bashay, Buger, Gyekrumlambo, Slahhamo, Rhotia Kainam, Chem, Changarawe | | | |
|  | |  | | | |
| g. Start date | | October 2019 | | | |
|  | |  | | | |
| h. End date | | 30 August 2022 | | | |
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| 1. Justification | | | | | |
| Smallholder farmers are consuming part of the harvest they produce. Hence, improved knowledge of the nutritional significance of a high diversity of foods will immediately impact their livelihoods. In this context, Ochieng et al. (2016[[31]](#footnote-32)) found that households benefiting from traditional African vegetables (TAV) promotion and demand creation activities had a significantly higher dietary diversity for children under five and women of reproductive age. Through a series of trainings and demonstrations, the target households have been taught how to develop vegetable-based recipes, the importance of eating a more nutritious and diverse diet and promoting better postharvest management of harvested vegetables.  Farm households and food kiosks have also been trained on general nutrition guidelines and the preparation of other nutritious recipes.  A baseline survey on 489 households was done in Karatu during the 2018-2019 period to assess the impact of nutritional education on farmers' nutritional knowledge, attitude and practices (KAP), income, and household nutrition. The baseline was done in 16 intervention villages. The baseline results showed that 30% of households from the intervention villages are not aware of the nutritional value of vegetables, and 80% believed that all vegetables contain the same nutrients necessary for human health and growth. Besides, more than 80% did not know the required quantity of vegetables and fruits to consume daily. Overall, these households consume a poorly diversified diet. Dietary diversity is still low, with households consuming on average six different food groups with the majority consuming cereal-based foods with fewer protein foods (such as eggs, meat, and fish). In 2021/2022, an endline survey will be conducted in the same households to assess the impact of these trainings on the household’s knowledge, attitudes, practices, and diets. | | | | | |
|  | | | | | |
| 1. Objectives | | | | | |
| 2.1 To assess the impact of nutritional intervention on farmers' nutritional knowledge, attitude and practices (KAP), income, and household diets   * 1. Assess the uptake of nutritious recipes by food kiosks/village restaurants | | | | | |
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| 1. Research questions: NA | | | | | |
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| 1. Experiment design, implementation, and data analysis | | | | | |
| The nutritional messages developed by Worldveg’s Nutrition-Sensitive Promotion of Vegetables (NutriSenseProm) project in Kakamega Kenya, were adapted to the local situation before training the households and food kiosks in Karatu. The intervention was done in 8 villages in generation 1 villages. During 2018/2019, 8 villages participated in the training, and 332 (160 males and 172 females) households were trained from these eight generation-1 villages. For the intervention areas/villages, the project employed two randomly assigned treatments: (1) Without any nutritional message (control)-10 groups, (2) Nutrition message 1 (M1) and nutrition message 2 (M2)-16 groups. Intervention groups were provided with seed kits to facilitate the production of tomato, African nightshade, and Ethiopian mustard and trained together with WorldVeg and IDP. For ethical reasons, the control group was also provided with seed kits so that the participants received some input and consequently received a kind of treatment at the end of the intervention (in 2021). Two sets of messages were tested. In addition, in 8 villages, 16 food kiosks (2 from each village) were trained to prepare different vegetable-based recipes for inclusion in their food menus. Data analyses will be done to assess the impact of nutritional messages and the adoption of vegetable-based recipes by kiosks and local restaurants.  A follow-up survey (endline) will be conducted in February 2022 in the same households that were interviewed during the baseline survey (489 households selected from 17 intervention groups - 8 old and 9 new villages) and 10 control groups). The study will use Difference in Difference (DiD) which helps estimate the impact of an intervention on different outcomes. DID is a quasi-experimental design that uses longitudinal data from treatment and control groups to obtain an appropriate counterfactual to estimate a causal impact. Where valid instruments will be available, an instrumental variable approach will be used to estimate the impact. | | | | | |
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| 1. Data (with indicators and metrics) to be collected and uploaded on Dataverse | | | | | |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/ landscape metrics | Measurement method | | Productivity | | | | | | | Vegetable productivity |  | kg/ha/season | kg/ha/season | - | Survey | | Post-harvest loss |  |  | % harvest lost |  | Survey | | Economic | | | | | | | Income diversification index |  | Diversification index (Simpson/ Herfindahl index) | Diversification index (Simpson/ Herfindahl index) |  | Survey | |  | Number of income sources | Number of income sources |  | Survey | | Market participation | - | - | % production sold | total sales | Survey | | Human Condition |  |  |  |  |  | | Nutrition | - | Availability of diverse vegetable crops (numbers) | Access to nutritious foods  Dietary diversity (24hr recall) | Dietary diversity (24hr recall) | Survey | | Food Security | - | - | Months of food insecurity |  | Focus group discussions (FGD) | | Social | | | | | | | Gender equity |  | Land access by gender  Market participation by gender  Rating of technologies by gender | Land access by gender  Market participation by gender  Rating of technologies by gender |  | Focus group discussions (FGD) | | Collective action |  |  | Participation in a collective action group (% of households in groups) | Number of collective action groups | Key informant interviews (KII)  & FGD | | | | | | |
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| 1. Deliverables: | | | | Means of verification | Delivery date |
| Manuscript on the impact of nutrition intervention on nutrition knowledge, attitudes, practices, and diets | | | | Submitted manuscript | Aug. 2022 |
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| 1. How will scaling be achieved? | | | | | |
| IDP to include nutrition training in other generation 2 villages. RECODA and MVIWATA to include nutrition education in their programs in other districts (e.g., in Babati). | | | | | |
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| 1. How are the activities in this protocol linked to those of others? | | | | | |
| Improved vegetable varieties and good agronomic practices for tomato and traditional African vegetables (TAV) are being scaled by IDP in 9 generation-2 villages (sub-activity 5.2.2.6). | | | | | |

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| 1. Gantt chart | | | | | | | | | | |
| Gantt chart | | | | | | | | | | |
| Year/month | 2021 | | 2022 | | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| 1. Nutrition training in 2 villages |  |  |  |  |  |  |  |  |  |  |
| 2. Development of data collection tools (questionnaire) |  |  |  |  |  |  |  |  |  |  |
| 3. Training of enumerators and pretest |  |  |  |  |  |  |  |  |  |  |
| 4. Household survey & key informant interviews |  |  |  |  |  |  |  |  |  |  |
| 5. Data cleaning and analyses |  |  |  |  |  |  |  |  |  |  |
| 6. Drafting and submission of the first manuscript on: *Impact of nutrition intervention on nutrition knowledge, attitudes, practices and diets* |  |  |  |  |  |  |  |  |  |  |

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| Outcome 3: Food and feed safety, nutritional quality, and income security of target smallholder families improved equitably (within households) | | | | | | | | | | |
| a. Output 3.1 | | | Demand-driven research products to reduce postharvest losses and improve food quality and safety piloted in target areas [and scaled in Outcome 5] | | | | | | | |
| b. Activity 3.1.1 | | | Conduct packaging and delivery of postharvest technologies through community and development partnerships with iterative review, refining, and follow-up | | | | | | | |
| c. Sub-activity 3.1.1.2: | | | Evaluate the influence of farmer storage structures and environment on the physical and economic losses abatement by hermetic storage devices | | | | | | | |
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| d. Systems research team | | | | | | | | | | |
| Name | | | Institution | | | Role | | | | |
| Gundula Fischer | | | IITA | | | Principal investigator, gender analysis | | | | |
| Julius Manda | | | IITA | | | Contribute to the development of the survey tool and analysis of socio-economic data | | | | |
| Christopher Mutungi | | | Consultant | | | Draft manuscript on “Differences in nutrition and welfare benefits of improved postharvest practices among men and women in rural Tanzania” | | | | |
|  | | | | | | | | | | |
| e. Student(s): Nil | | | | | | | | | | |
|  | | | |  | | | | | | |
| f. Location(s) | | | | Babati/ Karatu / Kongwa/ Kiteto Districts | | | | | | |
|  | | | |  | | | | | | |
| g. Start | | | | 2018 | | | | | | |
|  | | | |  | | | | | | |
| h. End | | | | 2022 | | | | | | |
|  | | | | | | | | | | |
| 1. Justification | | | | | | | | | | |
| This sub-activity continues as described in the 2019-2020 and 2020-2021 work plans; it got delayed due to COVID-19.  Postharvest losses reduce the food available for consumption and directly impact food security, nutrition, and household welfare. Improved technologies reducing postharvest losses can help farmers be more efficient, access better markets, or decrease the number of food deficit days enabling them to switch time and income expenditures to diversify diets or invest in household welfare items depending on context or typology. Since the inception of Africa RISING, improved post-harvest technologies and practices have been promoted in many communities in Tanzania, and one often hears stories from farmers about how they have improved nutrition, resilience, and quality of life. There is a need for a systematic study to measure these benefits within the frame of sustainable intensification and confirm the acceptability of the technologies. In 2018-2019, the technical superiority of different air-tight technologies for the storage of maize and beans in contrasting agro-locations was confirmed. There were outright differences in outcomes, which caused farmers to like some technologies more than others. Technologies will only be attractive to the extent of compelling farmers to invest in them if the perceived benefits substantially offset the costs (directly or indirectly) as opposed to technical superiority alone. Some benefits may be measured in monetary terms, while others may not be measurable. This study will generate data to fill this gap by confirming farmer acceptability of the technologies and potential impacts. | | | | | | | | | | |
|  | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | |
| 2.1 To study the gender aspects of different types of air-tight technologies for storage of cereals (maize) and legumes (beans) | | | | | | | | | | |
| 2.2 To assess the impacts of improved postharvest technologies on nutrition, food security, and welfare of farmers in Tanzania. | | | | | | | | | | |
|  | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | |
| 3.1 How do men and women farmers perceive and rate the benefits of different air-tight technologies for cereal and legume grain storage? | | | | | | | | | | |
| 3.2 What are the impacts of using improved postharvest technologies and practices on the nutritional, food security, and welfare of households in Tanzania? | | | | | | | | | | |
| 3.3 Are there potential differences in the achievement of nutrition, food security, and welfare benefits between men, women, and members of different age groups in the household? | | | | | | | | | | |
|  | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | |
| Experiment design, implementation, and data analysis:  This study will be conducted in two parts: The first part will apply focus group discussion, participatory exercises, and key informant interviews to study gender dynamics around the acceptability of different types of air-tight storage technologies by farmers. The gender study will align with the SI indicator framework so that gendered perceptions are captured in all SI domains (Fischer *et al*., 2018[[32]](#footnote-33)). In this part of the study, only farmers who used the technologies for at least one postharvest cycle will participate. Data will be transcribed and analyzed using qualitative methods. In the second part, a detailed socio-economic survey will be conducted using structured questionnaires to collect detailed data on demographics, food and non-food expenditure, food security, shocks, and safety nets, among others, from user and non-user households of postharvest technologies. Descriptive statistics and empirical modeling approaches, such as endogenous switching regression analysis, will be used in the data analysis. | | | | | | | | | | |
|  | | | | | | | | | | |
| 5. Data (with indicators and metrics) to be collected and uploaded on Dataverse | | | | | | | | | | |
| Domain & *Indicator* | Field/plot level metrics | Farm level metrics | | | Household level metrics | | | Community /landscape metrics | Measurement method | |
| Human | | | | | | | | | | |
| *Nutrition* |  |  | | | * Household dietary diversity score (HDDS) * Minimum Woman’s * Dietary Diversity Score (MDD-W); * Nutritional status (stunting, underweight, wasting) | | |  | Survey | |
| *Food security* |  |  | | | * Months of food insecurity * Rating of food security | | |  | Survey | |
| Social | | | | | | | | | | |
| *Gender equity* |  |  | | | * Nutrition by gender * Food security by gender * Rating of technologies by gender | | |  | Survey, Focus group discussions & participatory exercises | |
|  | | | | | | | | | | |
| 6. Deliverables | | | | | | | Means of verification | | | End date |
| Differences in nutrition and welfare benefits of improved postharvest practices among men and women in rural Tanzania  Additional manuscript on “Gendered benefits of different post-harvest technologies in Tanzania” | | | | | | | Report; draft manuscript for publication verified by Chief Scientist  Draft manuscript for publication verified by Chief Scientist | | | Sep. 2021  Completed  Jun. 2022 |
| Gender aspects of food safety in relation to maize | | | | | | | Report | | | Sep. 2021 |
| The role of social capital and networking in relation to the speed of postharvest technology adoption | | | | | | | Report | | | Apr. 2022 |
| Collected research data | | | | | | | Data uploaded on Dataverse | | | Jun. 2022 |
|  | | | | | | | | | | |
| 7. How will scaling be achieved? | | | | | | | | | | |
| Partnership with IDP to scale-out improved postharvest management technologies and practices to 1,800 new beneficiaries. Furtherance of scaling to be supported through short message service (SMS) on MWANGA Platform. | | | | | | | | | | |
|  | | | | | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | | | | | |
| This activity is linked to Integrated Soil Fertility Management System activities (1.1.1.6, 1.1.1.7, and 2.2.1.3) integrating maize and legume production in Babati and Kongwa, Kiteto. Findings will provide data for the human condition domain, nutrition, and food security. | | | | | | | | | | |

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| 9. Gantt chart | 2021 | | | 2022 | | | | | | | | |
| Activity/ month | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Data processing and analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| Preparation of scientific articles |  |  |  |  |  |  |  |  |  |  |  |  |
| Upload to Dataverse |  |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 3: Options for equitable food and feed safety, nutritional quality and income security of target smallholder families improved | | | | |
| a. Output 3.2 | Nutritional quality due to increased accessibility and use of nutrient-dense crops by farmers improved | | | |
| b. Activity 3.2.1 | Promote and deploy nutrient-rich crop varieties and livestock feed resources in target communities | | | |
| c. Sub-activity 3.2.1.1 | Elucidate pathways to sustainable adoption of nutrient diets and aflatoxin mitigation practices in rural communities of Central Tanzania (Assess the contribution of the farming systems interventions in narrowing the food and nutrient gaps in Kongwa Kiteto and the probability of smallholder farmer production to meet them) | | | |
|  | | | | |
| d. Systems research team: | | | | |
| Name | Institution | Role | | |
| James Mwololo | ICRISAT (PI) | Conceptualize and design studies  Coordinate assembly of data from both research and monitoring activities  Engage with other Africa RISING local and CGIAR partners  Collaboration on productivity data in different farming systems | | |
| Wanjiku Gichohi | ICRISAT (Co-PI) | Conceptualize and design studies  Coordinate assembly of data from both research and monitoring activities | | |
| Patrick Okori | ICRISAT (Co-PI) | Conceptualize and design studies  Coordinate assembly of data from both research and monitoring activities | | |
| Yacinta Muzanila | SUA (Co-PI) | Coordinate assembly of data from both research and monitoring activities. Support the development of an extension bulletin for nutrition | | |
| Daniel Mgalla | IITA (ESA M&E) | Provide support in monitoring the research activities to ensure compliance with the FtF monitoring system and uploading of data into the FtF data management system | | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s) | Kongwa, Kiteto | | | |
|  |  | | | |
| g. Start date | November 2014 | | | |
|  |  | | | |
| h. End date | June 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| Nutrition-sensitive agriculture and food systems can improve dependent communities' nutrition and health outcomes by sustaining the production of diverse, safe, and nutrient-rich food and income generation. It is, therefore, important to determine the capacity of households in the Africa RISING zone of influence to meet their food and nutrition security needs. This will show whether productivity-enhancing and scaling-out initiatives already contribute to nutrition and health outcomes. It will also inform whether adjustments are needed to meet dietary needs better. This study aims to understand better the extent to which rural households in central Tanzania meet their food and nutrient needs from their production and how that is associated with the quality of their diets. It will further investigate whether the Africa RISING focus crops and their associated commodities contribute significantly to the nutrition status of households. Some families in the study population have received improved seeds of legumes, cereals, and poultry and therefore provide a good opportunity as a control group to study adoption behavior. One of the causes of dis-adoption is the seasonality in the availability of certain foods.  Additionally, the study will assess the contribution of the farming system interventions in narrowing food and nutrient gaps in Kongwa and Kiteto and the probability of smallholder farmer production meeting them. We will develop food calendars that show the availability of locally sourced foods during the year in the study population. The study, therefore, aims to address household nutrition, a major livelihood issue. It starts with production and the associated technologies promoted by the different teams as the entry point, which is part of the food system (sub-activity 5.1.1, sub-activity 2.2.1.3, sub-activity 1.1.2.3).  In settings in which food supply is sufficient to deliver nutritious and balanced diets, the main impediment to access to such diets by households is usually income. Households may not be able to decide on affordable diets to meet their energy and nutrient needs even if they know what foods to eat or aspire to eat. Households living in dryland ecologies face this challenge as a double-faced threat of having minimal food sources during lean months of the year and excess food sources during the main cropping season. This may partly explain why in dryland ecologies, the livelihood risk is often higher with poor human health and nutrition indicators. For such communities, the development of a Food Calendar may address the double challenge of limited food availability or diversity. A Food Calendar provides information on foods available by season and the cost of accessing them. For a community that also practices livestock rearing, such a Food Calendar is also educational and informative for the design of scaling-out actions for affordable, nutritious diets and therefore supports sustained adoption. Previously, we have implemented and/or promoted nutritious diets in Kongwa and Kiteto.  In 2021-2022, we will finalize the two manuscripts and an extension bulletin promoting millets and pigeonpea for increased consumption. | | | | |
|  | | | | |
| 2. Objectives: To study the dynamics of access to nutritious foods in agro-pastoral communities of semi-arid agroecologies of central Tanzania through the development of food calendars and calculations of the costs of attaining nutritious diets by season | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1 Does increasing productivity of Africa RISING cereals, legumes, and animal products meet maternal diets' dietary diversity and nutrient adequacy? | | | | |
| 3.2 Does increasing productivity of the Africa RISING cereals, legumes, and animal products meet dietary diversity and nutrient adequacy of children’s diets? | | | | |
| 3.3 How does the farming system in agro-pastoral communities drive or affect food supply and consumption to meet the dietary demands of children, girls, and women? | | | | |
|  | | | | |
| 4. Experiment design, implementation, and data analysis: | | | | |
| 5. Data to be collected and uploaded on Dataverse   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method (details in research protocol) | | Human | | | | | | | *Nutrition* | *Protein Production* | Total protein production (g/ha) | Access to nutritious food  Food consumption score  Dietary diversity |  | Survey | |  | Total Micronutrient production | Total micro-nutrient production (g/ha)  Availability of diverse food crops | Potential/Actual protein availability |  | Survey  Lookup tables | | Human | | | | | | | Food security |  |  | Food availability  Food accessibility  Food utilization  Food security composite index | Total food production | Survey | | | | | |
|  | | | | |
| 6. Deliverables | | | Means of verification | End date |
| 6.1 Synthesis paper to inform future programming on how to link Agriculture and nutrition for food and nutrition security | | | manuscript | Jun. 2022 |
| 6.2 Draft manuscript on food and nutrient gaps and probability of farmer- increased productivity to meet them by use of new technologies | | | manuscript | Jun. 2022 |
| 6.3 Knowledge product: “Promoting increased consumption of millets and pigeonpea to enhance nutrition security” | | | Extension bulletin | May 2022 |

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| 7. How will scaling be achieved? |
| Through the partnership with interested non-governmental organizations and implementing nutrition-sensitive and specific activities. SUA will lead this activity supported by ICRISAT to develop the extension bulletin content and translate it to Swahili for local deployment by governments scaling up nutrition (SUN) movement. |
|  |
| 8. How are the activities in this protocol linked to those of others? |
| These activities are linked to the systems approach to generating evidence on the effect of productivity on nutrition. It will therefore feed into the systems agronomy, Gender, and M&E, and have a comprehensive view of the inter-linkages of Agriculture-Nutrition. |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 9. Gantt chart | | | | | | | |
| Year/month | 2021 | 2021 | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun |
| Technical report |  |  |  |  |  |  |  |
| Manuscript and synthesis paper |  |  |  |  |  |  |  |
| Extension bulletin |  |  |  |  |  |  |  |

Outcome 4: Functionality of markets, institutions, and partnerships associated with SI technologies through providing mechanisms that improve household linkages to markets improved

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Outcome 4: Functionality of markets, institutions, and partnerships associated with SI technologies through providing mechanisms that improve household linkages to markets improved | | | | | | | |
| a. Output 4.1 | | Access to profitable markets for smallholder farming communities and priority value chains facilitated | | | | | |
| b. Activity 4.1.1 | | Assess and develop best strategies for the groundnut seed value chain enhancement | | | | | |
| c. Sub-activity 4.1.1.2 | | Enhancement of the groundnut seed value chain enhancement in central Tanzania: Imperatives to inform its functionality | | | | | |
|  | |  | | | | | |
| d. Systems research team: | | | | | | | |
| Name | | Institution | Role | | | | |
| James Mwololo | | ICRISAT (PI) | Coordinate assembly of data from both research and monitoring activities. Engage with other Africa RISING local and CGIAR partners | | | | |
| Patrick Okori | | ICRISAT (CoPI) | Support development of tools and assembly of data from both research and monitoring activities. Engage with other Africa RISING local and CGIAR partners | | | | |
| Julius Manda | | IITA (CoPI) | Support assembly of data from both research and monitoring activities. Engage with other Africa RISING local and CGIAR partners | | | | |
| Daniel Mgalla | | IITA (ESA M&E) | To provide support in monitoring of the research activities to ensure compliance with FtF monitoring system, including periodically assisting in data collection (both FtF and Custom indicators data) with critical gender perspective and uploading of data into the FtF data management system | | | | |
| Extension officers | | DAICOs-Iringa, Kiteto, Kongwa | Support the survey teams (enumerators) as appropriate | | | | |
|  | | | | | | | |
| e. Student(s): Nil | | | | | | | |
|  | | | | | | | |
| f. Location(s): | | Kongwa, Kiteto | | | | | |
|  | | | | | | | |
| g. Start date | | May 2021 | | | | | |
|  | | | | | | | |
| h. End date | | April 2022 | | | | | |
|  | | | | | | | |
| 1. Justification | | | | | | | |
| We conducted a groundnut seed value chain analysis, mapped all the chain stages, and identified the main actors. The study showed that smallholders are finding opportunities in the seed value chain interventions, thus pointing to the need for an inclusive value chain development. Furthermore, the study identified several bottlenecks that impede the proper functioning of the value chain and its upgrading. The previous study looked at how inter-linkages between and within actors involved in the production, processing, and distribution of inputs, outputs, and bottlenecks. Yet, it didn’t link the functioning of these processes with specific outcomes relating to upgrading the groundnut seed value chain as the pathway towards smallholder integration into growing seed markets. The current study proposes to fill this gap. Seed multiplication was identified as one of the feasible options to enhance the functioning of the groundnut seed value chain. This can go a long way in stimulating the supply of quality seeds in the region. Developing a strategy that would ensure access to basic seed, credit services, functional markets, and extension support to feed to the seed multiplication initiative would make the groundnut seed value chain more vibrant. We propose to conduct a study to support the development of a concrete groundnut seed value enhancement strategy in readiness for its operationalization. Therefore, the study aims to identify upgrading options to develop a more inclusive groundnut seed value chain. | | | | | | | |
|  | | | | | | | |
| 2. Objectives | | | | | | | |
| To develop a groundnut seed value enhancement strategy in readiness for its operationalization to unlock its potential. | | | | | | | |
|  | | | | | | | |
| 3. Research questions | | | | | | | |
| 1. How can business linkages and inclusive coordination in the groundnut seed value chain be enhanced to improve its functionality? | | | | | | | |
|  | | | | | | | |
| 4. Experiment design, implementation, and data analysis | | | | | | | |
| The initial analysis will include refining the diagnostics by using the value chain analysis findings as the benchmark. This will consist of a checklist of questions such as: What is the value chain’s key transformation process)? What main inputs/actions does the transformation require? What are the critical resources necessary to complete the process? What are the characteristics of each link’s products or services, especially the production factors used and the life cycle? The second part of the study will include stakeholder meetings/focus group discussions herein referred to as dialogue tables as an opportunity for discussions around the bottlenecks limiting the groundnut seed value chain, agreeing and putting into action solutions beyond individual decisions. The approach is built on a collaborative platform for exchanging ideas and the driver for courses of action in support of the seed value chain stimulation. This will be the final part of the enhancement strategy development that would entail validation and enrichment of the information processed in the diagnostic (first part) and the formulation of the proposed strategies. | | | | | | | |
|  | | | | | | | |
| 5. Data (with metrics) to be collected and uploaded on Dataverse | | | | | | | |
| Domain and indicator | Field/plot level metrics | | Household level metrics | | Community/landscape metrics | Measurement method (details in research protocol) | |
| *Economic* |  | |  | |  |  | |
| *Market participation* | N/A | | % production sold | | Total sales | Survey | |
| *Market orientation* |  | | % land in cash crops  Market orientation index | |  | Survey | |
| *Social* | | | | | | | |
| *Social cohesion* | Participation in community activities | | Participation in community activities | | Social groups, Participation in social groups | Key informant interviews,  Focus group discussions | |
| *Equity* | Access to resources, capacity (access to information); Achievements (income, nutrition) | | Access to resources, capacity (access to information); Achievements (income, nutrition) | |  | Key informant interviews,  Focus group discussions | |
| *Collective action* | Participation in collective action group | | Participation in collective action group | | Collective action groups  Capacity of groups | Household survey  Focus group discussions | |
| Human condition | | | | | | | |
| *Capacity to experiment* |  | | No. of new practices being tested | |  | Focus group discussion | |
|  |  | | | | | | |
| 6. Deliverables: | | | | Means of verification | | | Delivery date |
| Critical information to inform the design of effective and efficient investments toward making the groundnut seed value chain more responsive and profitable. | | | | Study report | | | 30 Mar. 2022 |
| Publication; and extension bulletin | | | | Published manuscript on groundnut and maize seed value chains | | | 30 Mar. 2022 |

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| 7. How will scaling be achieved? |
| Through partnerships with the government, the private sector, and development partners to address the gaps identified towards making the groundnut value chain more responsive |
| 8. How are the activities in this protocol linked to those of others? |
| Multi-team participation leveraged for enhancing synergies between economics and gender |

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| 9. Gantt chart | | | | |
| Year/month | 2021 | 2021 | | |
| Dec | Jan | Feb | Mar |
| Study report |  |  |  |  |
| Manuscript |  |  |  |  |
| Extension bulletin |  |  |  |  |

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| Outcome 4: Functionality of input and output markets and other institutions to deliver demand-driven sustainable intensification research products improved | | | | |
| a. Output 4.1 | Access to profitable markets for smallholder farming communities and priority value chains facilitated | | | |
| b. Activity 4.1.1 | Conduct comprehensive value-chain analysis with specific focus on SI technologies | | | |
| c. Sub-activity 4.1.1.3 | Assess how ISFM practices affect farmers’ livelihoods as a result of Africa RISING activities in Babati | | | |
|  | | | | |
| d. Research team | | | | |
| Name | Institution | Role | | |
| Job Kihara | CIAT | PI | | |
| Jonas Julius/Rose Anael | MoA | Coordinate with village extension and local leaders for safe conduct of in-depth surveys | | |
| Prosper Massawe | TARI-Selian | Supervise enumerators conducting household surveys | | |
| Julius Manda | IITA | Provide technical review and critic of the survey tool to ensure compliance with requirements for outcome 5 of Africa RISING | | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  |  | | | |
| f. Location(s) | Long, Seloto, Sabilo, and Gallapo in Babati District, Tanzania | | | |
|  |  | | | |
| g. Start date | December 2013 | | | |
|  |  | | | |
| h. End date | November 2021 | | | |
|  | | | | |
| 1. Justification | | | | |
| Africa RISING has tested and demonstrated ISFM practices in Babati, Tanzania since 2013/2014. It is important to understand how these practices have been taken up by farmers, the extent of use by these farmers, and implications to key household level indicators including incomes and nutrition. Activities implemented previously related to the ISFM include linking farmers to input suppliers (improved seeds) and output markets through collective action. Farmers were also exposed to ISFM at different degrees including participation in demonstration trials, farmer field days, implementation of ISFM baby trials, farmer evaluation of technologies, hand-outs, and coupon farmers. The farmers themselves are of different wealth categories. This activity will help us understand the uptake of ISFM while considering these different contexts including the agro-ecological settings. Before the ISFM tests and demonstrations, an agronomic survey was conducted that can serve as an important baseline. This activity will unravel farmers motivation to invest or not invest in ISFM, the key challenges and identify opportunities.  Besides ISFM, Africa RISING has implemented and exposed farmers to other interventions related to the maize value chain. This is because the maize value chain is often fragmented and poorly coordinated with many layers and inefficient connections between producers and consumers. To overcome some of these problems, the Africa RISING project has been promoting the use of improved inputs such maize seed and inorganic fertilizers, improving access to these inputs, validating and promoting GAPs, encouraging the use of improved postharvest technologies such as tarpaulins, maize shelling machines, airtight storage containers, etc., linking farmers to profitable markets and encouraging cooperation amongst farmers to enable collective action for them to lower transaction costs and access better markets. We will assess how the various value chain interventions contribute to the upgrading of the maize value chain including generating the lacking evidence showing the effect of cooperation and collective action. | | | | |
|  | | | | |
| 2. Objectives | | | | |
| 2.1 To evaluate the uptake of ISFM by participating farmers and quantify the associated household-level benefits of implementing ISFM and identify opportunities and challenges to increase adoption | | | | |
| 2.2 To assess the impact of Africa RISING interventions in the upgrading of the maize value chain in Babati, focusing on SIAF domains | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1 To what extent are farmers implementing ISFM and what are the key determining factors  What is the impact of extent of ISFM use on household level indicators of income, food, and nutritional security? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| Experiment design, implementation, and data analysis: The data for this study will come from a larger maize value chain survey which will be conducted in Babati district consisting of 600 farmers.  The households will consist of maize producers as well as ISFM adopters bearing in mind the representation of women and youth farmers. Of the total of 600 households, 300 farmers will be purposively selected from those exposed to ISFM by the project covering at least 6 villages across four main ecozones of Babati. The survey will consist of an agronomic component with yield cuts in portions of farmer fields following the model used in Kihara *et al*., 2014[[33]](#footnote-34) (available [here](https://www.researchgate.net/publication/267338611_Agronomic_survey_to_assess_crop_yield_controlling_factors_and_management_implications_a_case-study_of_Babati_in_northern_Tanzania)) plus an additional component to understanding the overall household-level benefits and implications of ISFM, the expansion of ISFM, and the driving factors for these. These households will be purposively selected because it is a follow-up survey on the one conducted 2014 (see Kihara *et al*., 2014[[34]](#footnote-35)). The maize value chain survey tool will include information similar to the tool appended below specifically to capture data on agronomy. The other 300 households will be randomly selected through a stratified random sampling procedure. Similar data will be obtained as explained above but without the yield cuts from farmers’ fields. Data relating to the maize value chain e.g. maize production, marketing, and processing will be collected from all the 600 farmers. Besides, the survey will also collect information on collective action and farmers’ business relationships with input suppliers and traders/processors. Finally, the data collected will be analyzed taking into account levels of exposure/training, group participation e.g. through collective action. | | | | |
|  | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method (details in research protocol) | | Productivity |  |  |  |  |  | | *Crop productivity* | Maize, beans, pigeon pea productivity (kg/ha/season), and any other crop in system |  |  |  | Yield measurements | | *Variability of production* | Coefficient of variations by ISFM use |  | Rating of production risk | Variability of production¥ | Yield measurements/  Survey | | *Biomass productivity* | Maize, beans, pigeon pea biomass productivity (kg/ha/season), and any other crops |  |  |  | Yield measurements | | Economic |  |  |  |  |  | | *Profitability* | Gross margins ($/ha/ season)—aggregate for all crops in system | Gross margins ($/ha/ season) |  | (potential) Contribution to  regional or national  GDP | Yield measurements/  Survey | | *Labor requirement* | Labor requirement (hours/ha) |  | Farmer rating of labor |  | Survey | | *Variability of profitability* |  |  | Probability of low profitability |  | Yield measurements | | *Market participation* |  |  | % production sold |  | Survey | | Environmental | | | | | | | *Fuel availability* | Fuel biomass (kg/ha/season) |  | # months energy security | Diversity of fuel sources£  Spatial arrangement of fuel sources | Measurements/  Survey | | *Erosion* | Rating of erosion |  |  | Extent/variation of soil conservation measure under useµ | Survey | | *Soil Biology* | Labile or ‘active’ carbon  (POXC) |  |  |  | Soil tests | | *Soil quality* | Soil organic carbon and total N |  |  | Nutrient partial balance | Soil tests | | Human condition | | | | | | | *Nutrition* | Protein production (g/ha) |  |  |  | Field measurement/ lookup tables | | *Food security* | Food production (calories/ha/year) |  | Months of food insecurity; Rating of food security |  | Field measurement/ lookup tables/  Survey | | Social | | | | | | | *Gender equity* |  |  | Time allocation by gender |  | Household survey | |  |  | Management control by gender |  | Household survey | | Income by gender |  | Income by gender |  | Household survey | | *Equity* |  |  | Capacity (access to information) |  | Household survey | |  |  |  | Access to resources (land and livestock ownership) a |  | Household survey | | *Collective action* |  |  | Participation in a collective action group |  | Household survey | | | | | |
| £ we are introducing this. Understanding fuel sources at the household/community level is important to inform strengthening the promotion of alternative systems to save on environmental destruction i.e., vegetation clearing.  ¥ we want to know how ISFM intensity affects crop production variability at the community level.  µ we want to understand the soil and water conservation measures under use at the community level as a component of ISFM adaptation  NB: access to information and resources and participation in collective action will be considered required variables to explain the successes of ISFM | | | | |
|  | | | | |
| 6. Deliverables | | | Means of verification | Delivery date |
| 6.1 Journal article on the analysis of organic resources transfers and interactions with landscape positions influence crop yields among smallholder farmers in northern Tanzania | | | Published | May 2022 |
| 6.2 Journal article on Summary of Participatory action research, social networks, and gender influence soil fertility management in Northern Tanzania | | | Published | Apr. 2022 |
| 6.3 Journal article on Analysis on understanding the potential contributions of Integrated Soil fertility management to various sustainable intensification impact domains | | | Published | Jun. 2022 |
| Farmer and extension guide in English and Swahili translation | | | Published | Mar. 2022 |
|  | | | | |
| 7. How will scaling be achieved? | | | | |
| We are working in partnership with the Ministry of Agriculture Babati in an ongoing collaboration. The project supports participation in Nane-Nane exhibitions where key messages of our work are communicated. Besides, we developed a field guide that shows different best agronomic practices including implementation of ISFM practices. We intend to continue translating key results of our work into key messages through blogs but also utilize Mwanga ICT platform to communicate agronomic information. We will consider adding farmers participating in the survey under this activity into those already enlisted in Mwanga and receiving agronomic messages. | | | | |
|  | | | | |
| 8. How are activities in this protocol linked to those of others? | | | | |
| This activity is targeted to provide data in response to outcome 4 of the Africa RISING. It, therefore, links and contributes to the work by Julius Manda. We continue to assess biomass productivity which is a component also for livestock. Our approach of assessing the impact of ISFM applies to other sites e.g. Kongwa/Kiteto, and we want to know whether a similar approach and protocol can be applied there also. We are utilizing Mwanga ICT, a tool developed within Africa RISING. | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year/month | 2021 | 2022 | | | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Journal article on the analysis of organic resources transfers and interactions with landscape positions influence crop yields among smallholder farmers in northern Tanzania |  |  |  |  |  |  |  |  |  |
| Journal article on Summary of Participatory action research, social networks, and gender influence soil fertility management in Northern Tanzania |  |  |  |  |  |  |  |  |  |
| Journal article on Analysis on understanding the potential contributions of Integrated Soil fertility management to various sustainable intensification impact domains |  |  |  |  |  |  |  |  |  |
| Farmer and extension guide in English and Swahili translation |  |  |  |  |  |  |  |  |  |

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| Outcome 4: Functionality of input and output markets and other institutions to deliver demand-driven sustainable intensification research products improved | | | | |
| a. Output 4.1 | Access to profitable markets for smallholder farming communities and priority value chains facilitated | | | |
| b. Activity 4.1.1 | Conduct comprehensive value-chain analysis with a specific focus on SI technologies | | | |
| c. Sub-activity 4.1.1.4 | Assess how the implementation of ISFM practices affects farmers’ livelihoods as a result of Africa RISING activities in Kongwa | | | |
|  | | | | |
| d. Research team | | | | |
| Name | Institution | | Role | |
| Elirehema Swai | TARI Makutupora | | Overall supervision of data collection in Kiteto and Kongwa District | |
| Job Kihara | Alliance Bioversity CIAT | | Data analysis and write-ups | |
| Jackson Shija | Kongwa District Council | | Coordination with village extension and local leaders for the safe conduct of in-depth surveys | |
| Devotha Mchau | TARI Makutupora | | Supervising enumerators conducting household surveys | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s): | Mlali, Nghumbi, Sagara and Laikala | | | |
|  | | | | |
| g. Start date | November 2020 | | | |
|  | | | | |
| h. End date | November 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| Africa RISING has tested and demonstrated integrated soil fertility management (ISFM) practices in the Kongwa District, Tanzania, since the 2013/2014 cropping season to date. At this juncture, it is critical to understand how farmers took these practices, the extent of use, and the implications to key household-level indicators, notably income and nutrition. Activities implemented previously related to the ISFM, included the use of improved seeds (maize/sorghum), fertilizers, implementation of tied ridging, Fanya juu/chini terraces, among others. Farmers across participating villages were exposed to the ISFM technologies at varying degrees as a sound strategy for conserving the natural resource base in erosion-prone areas of central Tanzania. These included participation in demonstrations, farmer field days and implementation of ISFM baby trials, onsite training to strengthen farmers’ knowledge, and rollout of Fanya juu/chini terraces and tied ridging technologies. The resource endowment for farmers using ISFM technologies across the study area are of different categories.  In the 2020-2021 season, a survey was undertaken in four villages of the Kongwa district participating in the Africa RISING project. Similarly, soil and maize plant samples were collected from the same respondents. Analysis of soils and crop produce obtained from farmers is underway. Data cleaning, data entry, and analysis of soil and crop products are in progress. In the 2021-2022 season, the preparation of the manuscript will start in November 2021, and considering the nature of the study, it will require a rigorous data analysis, critical review of literature, and the preparation of the manuscript ready for submission. | | | | |
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| 2. Objective | | | | |
| 2.1 To quantify household-level benefits of implementing ISFM technologies/practices and identify opportunities and challenges to increase adoption | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1 To what extent are farmers implementing ISFM technologies/practices, and what are the key determining factors? | | | | |
| 3.2 What is the impact of ISFM use on household-level income, food, and nutritional security indicators? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| Experiment design, implementation, and data analysis  This study will be a detailed survey with at least 300 farmers (purposively selected from those exposed to ISFM by the project) covering at least three villages, the sorghum/pearl millet-based cereal system, and the maize-based cereal system in semi-arid areas of Kongwa district. The survey will consist of an agronomic survey with yield cuts in portions of farmer fields following the model used in Kihara *et al*. (2014[[35]](#footnote-36)) plus an additional component to understand the overall household levels benefits and implications of ISFM, the expansion of ISFM, and the driving factors for these. The agronomic survey tool will be adapted and expanded for this. The 300 farmers will be selected considering the representation of women and youth farmers. Data collected will be analyzed while considering levels of exposure/training, and group participation, e.g., through collective action. | | | | |
|  | | | | |
| 5. Data to be collected and uploaded on DataVerse | | | | |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method (details in research protocol) | | Productivity | | | | | | | *Crop productivity* | Maize productivity (kg/ha/season) and any other crop in the system |  |  |  | Yield measurements | | *Variability of production* | Coefficient of variations by ISFM use |  | Rating of production risk | Variability of production¥ | Yield measurements  Survey | | *Biomass productivity* | Maize, beans, pigeonpea biomass productivity (kg/ha/season), and any other crop |  |  |  | Yield measurements | | Economic | | | | | | | *Profitability* | Gross margins ($/ha/ season)—aggregate for all crops in system | Gross margins ($/ha/ season) |  | (potential) Contribution to  regional or national  GDP | Yield measurements  Survey | | *Labor requirement* | Labor requirement (hours/ha) |  | Farmer rating of labor |  | Survey | | *Variability of profitability* |  |  | Probability of low profitability |  | Yield measurements | | *Market participation* |  |  | % production sold |  | Survey | | Environmental | | | | | | | *Erosion* | Rating of erosion |  |  | Extent/variation of soil conservation measures under useµ | Survey | | *Soil Biology* | Labile or ‘active’ carbon  (POXC) |  |  |  | Soil tests | | *Soil quality* | Soil organic carbon and total N. |  |  | Nutrient partial balance | Soil tests | | Human condition | | | | | | | *Nutrition* | Protein production (g/ha) |  |  |  | Field measurement/  lookup tables | | *Food security* | Food production (calories/ha/year) |  | Months of food insecurity; Rating of food security |  | Field measurement/  lookup tables  Survey | | Social | | | | | | | *Gender equity* |  |  | Time allocation by gender |  | Key informant  interviews | |  |  | Management control by gender |  | Key informant  interviews | | Income by gender |  | Income by gender |  | Key informant  interviews | | *Equity (generally)* |  |  | Capacity (access to information) |  | Household survey | |  |  |  | Access to resources (land and livestock ownership) a |  | Household survey | | *Collective action* |  |  | Participation in a collective action group |  | Household survey | | | | | |
| £ we are introducing this. Understanding fuel sources at the household/community level is important to strengthen the promotion of alternative systems to save on environmental destruction, i.e., vegetation clearing.  ¥ we want to know how ISFM intensity affects the variability of crop production at the community level.  µ we want to understand the soil and water conservation measures under use at the community level as a component of ISFM adaptation  NB: access to information and resources as well as participation in collective action will be required as variables to explain the successes of ISFM | | | | |
|  | | | | |
| 6. Deliverables | | Means of verification | | Delivery date |
| 7.2 Draft publication summarizing survey data | | Draft article shared with Chief Scientist | | Mar. 2022 |
|  | | | | |
| 7. How will scaling be achieved? | | | | |
| In an ongoing collaboration, we are working in partnership with the local government, i.e., the district council. The project supports participation in Nane Nane exhibitions, where key messages of our work are communicated. | | | | |
|  | | | | |
| 8. How are activities in this protocol linked to those of others? | | | | |
| This activity will provide data for outcome 4 of the Africa RISING. It, therefore, links and contributes to the work of Julius Manda. We continue to assess biomass productivity which is a component also for livestock. Our approach to assessing the impact of ISFM is similar to other sites such as planned studies in Babati and Kongwa district councils; this allows for cross-site learning under different agro-ecologies. | | | | |

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| 9. Gantt chart | | | | | | | |
| Year/month | 2021 | | 2022 | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May |
| Data analysis |  | | |  |  |  |  |
| Literature search |  | | | |  |  |  |
| Write shop |  |  |  |  |  |  |  |
| Gather comments on the shared manuscript |  |  |  |  |  |  |  |
| Incorporation of comments into the manuscript |  |  |  |  |  | | |

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| Outcome 4. Functionality of input and output markets and other institutions to deliver demand-driven sustainable intensification research products improved | | | | |
| a. Output 4 | Access to profitable markets for smallholder farming communities and priority value chains facilitated | | | |
| b. Activity 4.1.1 | Conduct comprehensive value-chain analysis with specific focus on SI technologies | | | |
| c. Sub-activity 4.1.1.5 | Value chain analysis of nutrient-dense common bean varieties in Malawi | | | |
|  | | | | |
| d. Research team | | | | |
| Name | Institution | | Role | |
| Mankhwala Chifunilo | CIAT | | Research design, data collection, and report writing | |
| Julius Manda | IITA | | Assist with data analysis, manuscript development | |
| Regis Chikowo | MSU | | Research design, data collection, and report writing | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s) | Lilongwe, Ntchisi, Dedza EPAs | | | |
|  |  | | | |
| g. Start date | This is a follow-on study of previous common bean integration studies implemented by CIAT (Sub-activity 3.2.1.2 Promote farmer production of nutrient-dense (Zn, Fe) SER83 and NUA45 bean varieties) | | | |
|  |  | | | |
| h. End date | July 2022 | | | |
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| 1. Justification | | | | |
| A common bean value chain study was implemented in 2021. The study aimed to establish the market penetration of the bio-fortified common bean varieties introduced by CIAT. Micronutrients are essential to healthy diets. Micronutrient malnutrition caused by iron, iodine, vitamin A, and zinc deficiencies is one of the most important factors resulting in high mortality rates among children under five years of age, pregnant women, and lactating mothers in developing countries. In Malawi, on average 37% of the children are stunted, and anemia in children aged 6 – 59 months is about 64%. Coupled with this, about 20% of pregnant women are anemic. Common beans promise to overcome malnutrition due to their high protein and iron content.  Moreover, recent advances in research have made it possible to increase micronutrient content in beans through bio-fortification. To this end, CIAT - in collaboration with the Malawi national agricultural research system - released the bio-fortified common bean variety, NUA45, in 2016. The bean variety is bio-fortified with zinc and iron to address the aforementioned public health issues. The variety was also bred for marketability by ensuring large kernel size and red mottled attributes. NUA45 is an early maturing and high-yielding variety that can adapt to a changing climate. Preliminary results from the 2021 study show that traders are not considering the nutrient-dense properties of NUA45 as important in their business; they continue with their trading oblivious of this important trait. A premium price for the variety would increase the profitability of growing nutrient-dense varieties. These 2022 workplans will seek to complete the data analysis and publication of the work. Further, focus group discussions with groups of growers and traders will be held to probe how the market share of bio-fortified varieties can be enhanced. Brochures in the local language will be produced with relevant information as part of information dissemination. | | | | |
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| 2. Objectives | | | | |
| 2.1 To identify bottlenecks and opportunities in the bio-fortified common bean value chain  2.2. To produce a manuscript on the common bean value chain | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1 What opportunities and constraints exist along the bio-fortified common value chain? | | | | |
|  | | | | |
| 4. Experiment design, implementation, and data analysis | | | | |
| The data for this sub-activity has already been collected from both primary and secondary sources. The primary data was obtained through interviews with actors at each stage of the value chain (input supply, production (farmers), assembling, and marketing) in the common bean producing areas of Dedza and particularly in Linthipe where Africa RISING introduced NUA45. The Lilongwe Ntchisi common bean market was also central to this study. Key informant interviews were conducted to collect information from input suppliers, large-scale traders, exporters, and service providers that support the value chain. Data has been analyzed partially using Stata and SPSS software. Specifically, value chain maps showing the direction of flow of bio-fortified common beans and products from production to consumption are being developed. Specialized indices such as the Herfindahl-Hirschman Index (HHI), Marketing Efficiency Index (MEI), and Marketing Margins are used to assess the efficiency of the biofortified common bean value chain. | | | | |
|  | | | | |
| 5. Data (with metrics) to be collected and uploaded on DataVerse | | | | |
| The data mentioned below will be refined during 2022 as part of manuscript development   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community /landscape metrics | Measurement method | Responsible | | Productivity | | | | | |  | | *Common bean grain productivity* | bean grain yield (kg/ha/season) |  |  |  | survey | MSU | | Economic |  |  |  |  |  |  | | *Profitability* | Net income ($/crop/ha/season);  Gross margin |  |  | Market participation (% share) | Survey | IITA/MSU | | Human condition | | | | | | MSU | | *Nutrition* | Protein production (kg/ha); Zn and Fe production (g/ha) |  |  |  | Lookup tables | MSU | | *Food security* | Food production  (calories/ha/year) |  | Months of food insecurity |  | Lookup tables, survey | MSU | | Social |  |  |  |  |  |  | | *Gender equity* | Rating of technologies by gender |  |  |  | Participatory evaluation | MSU | | | | | |
|  | |  | |  |
| 6. Deliverables | | Means of verification | | Delivery date |
| Value chain mapping finalized | | Value chain map of bio-fortified beans in Malawi | | Mar. 2022 |
| 6.1 Scientific publication | | Manuscript submitted to a journal | | May 2022 |
|  | | | | |
| 7. How will scaling be achieved? | | | | | |
| Scientific publication in an appropriate social science/economics journal | | | | | |
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| 8. How are the activities in this protocol linked to those of others? | | | | | |
| Farmers will be selected from those that previously implemented research with CIAT | | | | | |

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| 9. Gantt chart | | | | | | | | | | |
| Year/month | 2021 | | 2022 | | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Focus group discussions with growers and traders for further feedback on common bean value chains |  |  |  |  |  |  |  |  |  |  |
| Further data analysis, scientific manuscript development, and report writing |  |  |  |  |  |  |  |  |  |  |
| DataVerse data upload |  |  |  |  |  |  |  |  |  |  |

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| Project Outcome 4: Functionality of input and output markets and other institutions to deliver demand-driven sustainable intensification research products improved | |
| Output 4.1 | Access to profitable markets for smallholder farming communities and priority value chains facilitated |
| Activity 4.1.5 | Conduct an analysis of the existing baseline survey data and supplement them with qualitative surveys from target regions |
| Sub-activity 4.1.5.1. | Impact of smallholder Agricultural commercialization on household income and nutrition in Ghana and Malawi |

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| --- | --- | --- |
| Name | Institution | Role |
| Julius Manda | IITA | PI (Agricultural economist, research design, data analysis and writing) |
| Bekele Kotu | IITA | Agricultural economist, research design, data analysis and writing |
| Carlo Azzarri | IFPRI | Agricultural economist, research design, paper revision |
| Shiferaw Feleke | IITA | Agricultural economist, research design, paper revision |
| Consultants | * University Ahmadu Bello University, Nigeria * University for Development Studies, Ghana * MwAPATA institute, Malawi | Agricultural economists, data processing and analysis |

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| Student(s): NIL | | | | | | | |
|  | | | | | | | |
| Location (s) | |  | | Ghana and Malawi | | | |
|  | |  | |  | | | |
| Start | |  | | June 2021 | | | |
|  | |  | |  | | | |
| End | |  | | September 2022 | | | |
|  |  | | | | | | |
| 1. Justification | | | | | | | |
| Agricultural productivity growth has long been recognized as one of the most important and effective pathways through which agricultural research and technologies can increase rural incomes, nutrition and reduce poverty (Gollin, Hansen, and Wingender, 2021)[[36]](#footnote-37). However, the link between agricultural research and nutrition is not straightforward as benefits may not be accrued uniformly across different income groups. Previous studies have shown that Agricultural commercialization is one of the pathways through which farmers can increase income and nutrition (Ogutu and Qaim, 2019[[37]](#footnote-38); Carletto et al., 2017[[38]](#footnote-39)). Commercialization will be measured based on farmers’ agricultural production and marketing activities using baseline and end-line survey data in Ghana and Tanzania. We will consider all crop and livestock enterprises of the farm household. Specifically, the level of household agricultural commercialization will be measured as the share of total farm output sold in the two-survey periods. Based on this definition, the process of agricultural commercialization can be represented by an index (CI) ranging from pure subsistence (CI = 0) to a completely commercialized production system (C1 = 100)[[39]](#footnote-40). Unlike the common binary measures of sellers versus non-sellers, or between staple and cash crop producers, this index also measures how much of the farm output households choose to sell. Considering the limited empirical evidence of the impact of agricultural commercialization on income and nutrition, this study aims to fill this gap based on panel household survey data from Malawi and Ghana. | | | | | | | |
|  | | | | | | | |
| 2. Objective | | | | | | | |
| To examine how agricultural commercialization can increase smallholder household incomes and nutrition | | | | | | | |
|  | | | | | | | |
| 1. Research questions | | | | | | | |
| 1. Does agricultural commercialization improve smallholder farmers’ income? | | | | | | | |
| 2. Does agricultural commercialization improve smallholder farmers’ nutrition status? | | | | | | | |
|  | | | | | | | |
| 4. Data collection and analysis | | | | | | | |
| The data for this study will come from Africa RISING baseline and end-line surveys in Ghana and Malawi. We will apply innovative estimation methods to control for observed and unobserved characteristics that would otherwise bias our results. Specifically, we will use the correlated random effects (CRE) model to estimate the impact of commercialization on income and nutrition. The CRE estimator allows us to examine the effects of observable time-constant determinants by including a vector of time-averaged variables, which the fixed effects (FE) estimator cannot do (Wooldridge, 2010)[[40]](#footnote-41). Moreover, it allows for correlation between unobserved and observed factors, which the random effects (RE) estimator assumes to be zero (Burke et al., 2020[[41]](#footnote-42); Wooldridge, 2010). | | | | | | | |
|  | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | Responsibility/Institute | |
| The study uses existing databases. | | | | | | IFPRI, IITA | |
| Domain | Indicator | | Household-level | | | Measurement | |
| Economic | * Level of output commercialization * Income from agricultural output sales | | * Proportion of output sold * Income per household (per capita) per year ($/ha) (scale) | | | Household panel data | |
| Human | Household nutrition status | | * Dietary diversity score (scale, household level) | | |  | |
|  | | | | | | | |
| 6. Deliverables | | | | | Means of verification | | Delivery date |
| The impacts of smallholder Agricultural commercialization on household income and nutrition in Ghana and Malawi estimated | | | | | Notification from a journal after manuscript submission | | June 2022 |
|  | | | | | | | |
| Sustainable intensification indicators | | | | | | | |
|  | | | | | | | |
| 7. How will scaling be achieved? NA | | | | | | | |
|  | | | | | | | |
| 8. How are the activities in this protocol linked to those of others? This activity is linked to Sub-activity 4.1.5.1.: Identify the most profitable market channels and welfare effects of participating in the maize, groundnuts, and pigeon peas markets in Malawi, Tanzania, and Zambia | | | | | | | |

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| 9. Gantt chart | | | | | | |
| Year/month | 2021 | | | | 2022 | |
| Sep | Oct | Nov | Dec | Jan | Feb |
| Data analysis |  |  |  |  |  |  |
| Draft manuscript write-up |  |  |  |  |  |  |

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| Project Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| Project Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| a. Output 5.1: | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | |
| b. Activity 5.1.1: | Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations | | | |
| c. Sub-activity 5.1.1.1: | Continued experimentation in 6 target communities of Eastern Zambia and ten target communities in central and southern Malawi with already established clustered CA trials | | | |
|  | | | | |
| d. Systems research team: | | | | |
| Name | Institution | | Role | |
| Christian Thierfelder | CIMMYT | | PI, design, agronomic assessment | |
| Consultant | IITA | | Socio-economic linkage to agronomic work (Level of effort 20 consultancy days) | |
| Julius Manda | IITA | | Socio-economic research | |
| Richard Museka | TLC | | Implementation and scaling | |
| Mphatso Gama | Machinga ADD | | Implementation and scaling | |
| Mulundu Mwila | ZARI | | Implementation and scaling | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s): | Hoya, Vuu, Kapara, Mtaya, Chanje, Kawalala in Eastern Zambia  Mwansambo, Zidyana, Chinguluwe, Chipeni, Linga, Lemu, Herbert, Malula, Matandika, Songani in Malawi | | | |
| g. Start date | This is a continuing multi-year study that has been running since 2011 in Zambia and since 2004/2005 in Southern and Central Malawi | | | |
|  | | | | |
| h. End date | October 2022 | | | |
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| 1. Justification | | | | |
| Smallholder farmers in southern Africa are affected by climate change and soil fertility decline, being the primary reason for establishing CA long-term trials. Throughout the years, these trials evolved from simple CA systems trials to more sophisticated CA long-term trials with maize doubled-up legumes:   * Due to the long-term nature of these trials, we can reasonably expect that some of the soil quality indicators (soil chemical properties) have evolved and can now be analyzed in the form of a final assessment. We would lose a great deal of high-quality scientific information as some of these sites are more than 16 years old, and this is unique in Africa. This will also help us assess the resilience of the CA technologies investigated in these long-term trials. * We have modified the trials to have a maize-doubled-up legume rotation for the last three years based on recommended technology interactions with MSU. We have not yet seen the full benefit of this technology strategy which requires the last year’s data. * The long-term on-farm sites are further required to serve as an anchoring point to conduct remaining research on profitability (e.g., longer-term economic benefits), technological choice by farmers, and human impacts, which have been jointly planned with socio-economist for this last year. The argument is that they cannot do this kind of research without a context-specific geographic location where they can do the research. * Finally, the long-term on-farm sites are our direct link with the development partners from the public and private sector extension. These points not only serve as learning grounds, places for technology evaluation, and field day activities – they are also prestigious to the Ministry of Agriculture staff as they fully own them and can be used as reference points in their work.   The proposed emphasis is on closing identified knowledge gaps in the logframe in the environmental, social, economic, and human domains while maintaining the on-farm long-term trials as anchoring points for this research. In collaboration with the IITA regional scientist, the impact of technological interventions will be further assessed in an impact study to contribute to the final project report (e.g., we will gather returns on investment, yield increase per investment, calorie/protein benefits, amongst others). | | | | |
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| 2. Objectives | | | | |
| To demonstrate the best options available for managing drought-tolerant maize varieties and conservation agriculture practices in 16 target communities of Malawi and Zambia. Conservation agriculture implies surface crop residue retention, minimum soil disturbance, and crop rotation. Both animal traction and manual systems will be tested. | | | | |
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| 3. Research questions | | | | |
| * How can CA and associated practices increase food security and resilience of low-input agriculture systems? * How can improved legume systems enhance the productivity and profitability of these farming systems? * What economic, social, and human benefits of CA systems can be expected in the short and long term? * What are the barriers to CA adoption? | | | | |
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| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| Experiment design, implementation, and data analysis  Final research in this activity will be conducted in already established on-farm long-term trials using previously developed protocols and datasheets. These trials have been running for ten years in Zambia and up to 17 years in Malawi. Sixteen research clusters in on-farm target communities will be used to finalize research on CA systems in these research areas.  In brief, each research cluster in a target community consists of 6 replicated farmers’ fields with technology testing and socio-economic data taking. Within each farmers’ field, several technology components are on trial, consisting of no-tillage, residue retention, rotation, intercropping, drought-tolerant seed, and doubled-up legume systems that are compared against the conventional control practices tillage, residue removal, monocropping. The treatments and different management strategies are summarized in Table 1 below.  *Table 1:* Treatments tested in different target areas of southern Africa under Africa RISING   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Site cluster | Conventional system | CA option 1 | CA option 2 | CA option 3 | | Central Malawi | Ridge tillage, maize- legume rotation | Dibble stick, maize- doubled-up legume rotation | Dibble stick, maize/legume intercropping- legume rotation |  | | Trials were sequentially established from 2005 onwards. All maize has been fully rotated with groundnuts since 2010, and since 2013, maize plots have been sub-divided into six subplots testing five drought-tolerant maize varieties and a conventional control. Fertilizer level is 69 kg ha-1 N:21 kg ha-1 P2O5:0 kg ha-1 K20: 4 kg ha-1S | | | | | | Southern Malawi | Ridge tillage, maize- legume rotation | Dibble stick, maize- doubled-up legume rotation | Dibble stick, maize/legume intercropping—doubled-up legume rotation |  | | Trials were sequentially established from 2005 onwards. All maize has been fully rotated with pigeonpeas, cowpeas, or groundnuts since 2011 depending on the sites, and since 2013, maize plots have been sub-divided into six subplots testing five drought-tolerant maize varieties and a conventional control; Fertilizer level is 69 kg ha-1 N:21 kg ha-1 P2O5:0 kg ha-1 K20: 4 kg ha-1S | | | | | | Eastern Zambia  (manual) | Ridge tillage, maize | Dibble stick, maize | Dibble stick, maize-legume intercropping | Dibble stick, maize- rotation | | Eastern Zambia  (animal traction) | Conventional moldboard plowing, maize | Rip line seeding/direct seeding, maize | Rip line seeding/direct seeding, maize- legume rotation |  | | Trials were established from 2011 onwards. All maize was planted as sole continuous crop, intercrop, or in full rotation; Fertilizer level is 108 kg ha-1 N:40 kg ha-1 P2O5: 20 kg ha-1 K20 | | | | |   The on-farm trials have been traditionally used to study productivity and environmental indicators but will be used in this final year for detailed studies of environmental indicators (soil carbon, infiltration); farmers’ perception of technologies and farmers’ choice; detailed studies on economic profitability; and for other studies on labor use and distribution amongst gender groups (see indicator matrix). Different sampling strategies and measurement methods will be used to assess the socio-economic effects of CA, ranging from targeted participatory rural appraisals (PRAs) and socio-economic surveys led by a consultant. | | | | |
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| 5. Data (with indicators and metrics) to be collected and uploaded on Dataverse | | | | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | SI Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method (details in research protocol) | Responsible | | Productivity | | | | | |  | | *Crop productivity* | Yield (kg/ha/season); |  |  |  | Crop cuts and detailed yield measurement | Christian Thierfelder | | *Crop biomass productivity* | Residue production (kg/ha/season |  |  |  | Crop cuts and detailed yield measurement | Christian Thierfelder | | Economic | | | | | |  | | *Profitability* | Gross margin (USD/ha/season) |  |  |  | PRA | Christian Thierfelder and Julius Manda | | *Returns to land, labor, input* | Returns to investment |  |  |  | Survey | Christian Thierfelder and Julius Manda | | *Labor requirement* | Labor requirements |  |  |  | Survey | Christian Thierfelder and Julius Manda | | *Labor requirement* | Farming rating of labor |  |  |  | PRA | Christian Thierfelder and Julius Manda | | Environmental | | | | | |  | | *Soil biology* | Total Carbon (%) |  |  |  | Soil analysis of on-farm sites in laboratory | Christian Thierfelder | | *Erosion* | Rating of erosion | Rating of erosion |  |  | Farmer rating | Christian Thierfelder | | *Infiltration* | Time to Pond measurement |  |  |  |  | Christian Thierfelder | | Social | | | | | |  | | *Equity (generally)* | Rating of technologies by gender |  |  |  | PRA | Christian Thierfelder | | *Gender equity* |  |  | women’s time and empowerment index |  | Survey | Julius Manda | | Human | | | | | |  | | *Nutrition* | Protein production (g/ha) |  |  |  | Survey | Christian Thierfelder | | *Nutrition* |  |  | Dietary diversity score |  | Survey | Julius Manda | | *Nutrition* |  |  | Food consumption score |  | Survey | Julius Manda | | *Food security* |  |  | Months of food insecurity |  | Survey | Julius Manda | | *Food security* |  |  | Food security composite Index |  | Survey | Julius Manda | | *Food security* |  |  | Rating of Food security |  | Survey | Julius Manda | | | | | |
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| 6. Deliverables: | | Means of verification | | Delivery date |
| 6.1 Trials designed and protocols updated | | Protocol available (no change) | | Oct. 2021 |
| 6.2 Trials established | | Technical report | | Mar. 2022 |
| 6.3 Monitoring | | Field tours, report | | Apr. 2022 |
| 6.4 Data generated and uploaded | | Annual Report, end of project report | | Sep. 2022 |
| 6.5 Knowledge products for smallholder farmers | | Farmer Manual for the implementation of CA systems | | First draft by Jun. 2022; final product by Sep. 2022 |
| 6.6 Two peer-reviewed publications on nutrition and GxExM | | Manuscript and Publication | | First drafts by Jun. 2022; final product by Sep. 2022 |
| 6.8 Upload data into Dataverse | | Data uploaded | | Sep. 2022 |
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| 7. How will scaling be achieved? | | | | |

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| * Malawi and Zambian extension system at the district level (e.g., the District Agricultural Extension Coordinating Committees – DAECC in Malawi) is a prime vehicle for disseminating improved CA technologies to other EPAs and districts. Ministry of Agriculture Extension service will continue supporting CIMMYT in scaling activities. * CIMMYT will get evidence of all programs that currently promote CA scaling in the region and summarize these to better understand what scaling technologies work, which enablers are fruitful, and what regulations foster these systems' out-scaling. |
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| 8. How are activities in this protocol linked to those of others? |
| Data from CA on-farm trial are important in the Maize-Legume system assessment, and CIMMYT will collaborate with Francis Muthoni on targeting and Julius Manda on the economic data. |

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| 9. Gantt chart | 2021 | | | 2022 | | | | | | | | |
| Activity/ month | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Contracting and finalization of subgrants |  |  |  |  |  |  |  |  |  |  |  |  |
| Field implementation |  |  |  |  |  |  |  |  |  |  |  |  |
| Field visits and tours |  |  |  |  |  |  |  |  |  |  |  |  |
| Evaluation meetings |  |  |  |  |  |  |  |  |  |  |  |  |
| Development of Farmer manual |  |  |  |  |  |  |  |  |  |  |  |  |
| Publication |  |  |  |  |  |  |  |  |  |  |  |  |
| Harvest |  |  |  |  |  |  |  |  |  |  |  |  |
| Analysis and summary |  |  |  |  |  |  |  |  |  |  |  |  |
| Report writing |  |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| a. Output 5.1 | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | |
| b. Activity 5.1.1 | Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations | | | |
| c. Sub-Activity 5.1.1.2 | Explore the productivity domains of selected legumes and cereals to elucidate their best fitting cropping system at community/landscape level and their dissemination | | | |
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| d. Systems research team: | | | | |
| Name | Institution | Role | | |
| James Mwololo | ICRISAT (PI) | Coordinate assembly of data, analysis, and drafting of the manuscript | | |
| Patrick Okori | ICRISAT (CO-PI) | Coordinate assembly of data, analysis, and drafting of the manuscript | | |
| Daniel Mgalla | IITA (ESA M&E) | Provide support to ensure compliance to FtF monitoring system, including Custom indicators data) and uploading of data into the FtF data management system | | |
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| e. Start date | November 2018 | | | |
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| f. End date | July 2022 | | | |
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| 1. Justification | | | | |
| In the last two years, we evaluated and identified genotype-by-management fit of these materials in three sub-agroecologies and found that three factors critical for increased productivity i.e., (i) a shift to intercropping, (ii) early planting that increased yields in legumes- groundnut short duration (13% over medium duration and 91% over landrace); medium-duration pigeonpea (13%)- and with long duration 33%) and; dryland cereals (133%-44%), for sorghum and pearl millet respectively, when planted early/timely, in the right sub-agroecology. Differences in productivity between moderately and highly productive sub-agroecologies in the 2019-2020 cropping year were generally minimal, although in many cases, under timely planting, productivity differences were larger when compared with the low potential sub-agroecology. Even there, early planting was beneficial. We understand the ecology x genotype and management fit, with data assembled for SIAF indicators on productivity (grain yield t/ha) and economic benefits – (gross margins/ha). However, we need to assemble the critical set of SIAF indicators human and social indicators marked. For this purpose, additional data was collected in the year 2020-2021 cropping season that will inform scaling. In the 2021-2022 season, the data collected over the years will be blended to finalize and publish two manuscripts in peer-reviewed journals.  To support the dissemination of knowledge, knowledge products will be developed, including one extension bulletin and one technology label. | | | | |
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| 2. Objectives | | | | |
| To evaluate the performance of proven legume-legume (groundnut and pigeonpea) and legume-cereal (sorghum and pearl millet + pigeonpea) intercrop systems to deliver critical livelihood benefits to farming communities in stressed and moderately stressed sub-agroecologies of Kongwa and Kiteto. | | | | |
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| 3. Research questions | | | | |
| How do the proven cropping systems and associated technologies affect key livelihood areas of economic, social, food, and nutrition security needs of farming communities in these dryland agro-ecologies? | | | | |
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| 4. Experiment design, implementation, and data analysis | | | | |
| These studies were implemented at plot and farm level, to collect data on production, economic, social, and human SIAF domains. To collect data at the farm level, the study followed a randomized control trial design; the same population differed concerning access to or adoption of Africa RISING agri-innovations generated by the project activities. The study population comprised an experimental/beneficiary household cohort and a counter-factual/non-beneficiary household cohort, the negative control. Beneficiary households were those hosting baby trials or active members of community seed banks and seed producer associations created by Africa RISING. The counter-factual cohort comprised farm households that had not received any Africa RISING agri-innovations. The study was implemented in two contrasting production environments identified earlier as the major agro-ecologies in these drylands. Proven legume-legume and legume-cereal production technologies were established in contrasting environments, and data were collected on the focus SIAF domain indicators from the two study cohorts. Farm-level data was validated using researcher-managed plots. Plot level data from previous seasons was used to study trends in gross margins of the technologies, the economic domain indicator we used previously. Economic data at the farm level was assembled through a survey and will be used to compute the selected domain indicators. Economic domain data was obtained from groups and individuals. Data for the social domain indicators were collected from the community seed bank beneficiaries, groups/associations, using participatory evaluation of technologies in gender-disaggregated groups. As appropriate, focus group discussions and or participatory exercises were used. Both qualitative and quantitative data were collected. To investigate how changes in cropping systems affect the farming system, spider diagrams and trade-off analysis will be performed using the SIAF indicator domain data. This will elucidate the impact of innovations on livelihood options and identify promising choices with the least penalty. Complete set of proven innovations. | | | | |
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| 5. Data collected and uploaded on Dataverse   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method (see details in research protocol) | | Productivity | | | | |  | | *e.g., Crop (*maize, sorghum, pigeonpea and groundnut*) productivity* | Yield (kg/ha/season) | Yield (kg/ha/season) | Food supply |  | Yield measurement | | *e.g., Crop (*maize, sorghum, pigeonpea and groundnut*) biomass productivity* | Residue production (Kg/ha/season) | Residue production (Kg/ha/season) |  |  | Yield measurement | |  | Yield gap per crop (kg/ha/season) | Yield gap per crop (kg/ha/season) |  |  | Yield measurement | | Economic | | | | |  | | *Profitability* | Net income ($/crop/ha/season) | Net income (Total net income for all farm activities) |  |  | Participatory Evaluation | | *Labor requirement* | Labor requirement (hours/ha) | Labor requirement (hours/ha) |  |  | Direct observation/farmer evaluation | | Input use intensity | Input per ha | Input per ha | Input per ha |  |  | | *Income diversification* |  | Sources of income | Sources of income |  | Survey among beneficiaries | | Human condition | | | | |  | | *Capacity to experiment* |  |  | No. of new practices being tested | Percentage of farmers experimenting | Focus group discussion | | *Nutrition* | Protein production (g/ha) | Protein production (g/ha)  Availability of diverse crops |  |  | Participatory assessment  Survey | | *Food security* | Food production  (Calories/ha/year) | Food production  (Calories/ha/year) |  |  | Participatory assessment  Survey | | *Food availability* |  |  |  |  |  | | Social | | | | |  | | *Equity* | Rating of technologies by group  Capacity to access information | Rating of technologies by group  Capacity to access information |  |  | Participatory Evaluation/key informant interview | | *Social cohesion* | Participation in community activities | Participation in community activities | Participation in community activities. | Participation in social groups | Key informant interviews  Focus group discussions | | | | | |
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| 6. Deliverables | | | Means of verification | End date |
| Two manuscripts  1. Yield Advantage of Elite Cereal and Legume Genotypes in Varying Potential Agro-ecologies of Central Tanzania  2. Participatory Variety Selection (PVS) as a tool for variety development: A case study for the Africa RISING project in Tanzania and McKnight CCRP Project in Malawi | | | Published manuscripts | Jul. 2022 |
| Knowledge product developed  Technology label: “Cereal-legume intercropping options for central Tanzania” | | | One Technology label produced | Mar. 2022 |

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| 7. How will scaling be achieved? |
| Partnerships: Building on the partnerships with TARI Institutes (Makutupora), the Local Governments (through the DAICO offices)- our long-term partners for research to delivery, as well as our new partnerships involving Kibaigwa Flour supplies -KFS and Dodoma Agricultural Seed Producers’ Association- DASPA, the team, will leverage these partners and their networks to disseminate the knowledge products. |
| Knowledge dissemination: Dissemination of knowledge will be achieved through the publications and technology label |
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| 8. How are activities in this protocol linked to those of others? |
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| 9. Gantt chart | | | | | | | |
| Year/month | 2021 | 2021 | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun |
| Manuscript development |  |  |  |  |  |  |  |
| Development of knowledge products |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | | |
| a. Output 5.1 | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | | |
| b. Activity 5.1.1 | Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations | | | | |
| c. Sub-activity 5.1.1.4 | Case studies: Application of SI technologies use among farmers interacting with Africa RISING at different intensities | | | | |
|  |  | | | | |
| d. Research team | | | | | |
| Name | Institution | Role | | | |
| Regis Chikowo | MSU | PI, Research design, supervision of fieldwork, MSc student; Modules 1 and 2 | | | |
| Sieg Snapp | MSU | Support PI | | | |
| Wezi Mhango | LUANAR | Fieldwork, MSc student | | | |
| Christian Thierfelder | CIMMYT | Conservation agriculture integration, southern Malawi sites | | | |
| Julius Manda | IITA | Socio-economics analyses (Module 3) | | | |
| Jeroen Groot | WUR | Farming Systems analysis with FarmDESIGN model | | | |
|  | | | | | |
| e. Student(s) | | | | | |
| Name | Institute | Degree | | Start | End |
| Tinashe Taringa and Isaac Maviko | LUANAR and University of Zimbabwe | MSc | | Oct. 2019 | May 2022 |
| WUR MSc student | WUR | MSc | | Nov. 2021 | Aug. 2022 |
|  | | | | | |
| f. Location(s) | Golomoti, Kandeu, Linthipe (MSU led long-term experiments in these EPAs);  Lemu, Matandika, Songani (CIMMYT led long-term experiments in these EPAs) | | | | |
|  | | | | | |
| g. Start date | October 2019 | | | | |
|  | | | | | |
| h. End date | September 2022 | | | | |
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| 1. Justification | | | | | |
| This sub-activity was framed during the 2019-2021 annual review and planning meeting. However, COVID-19 disrupted the full implementation of activities during 2020. Fortunately, data collection was completed in 2021 for all three modules. Briefly, this research is based on tracking farmers who have interacted with MSU and CIMMYT led activities in central and southern Malawi. MSU, leading the Africa RISING project component, started interacting with farmers during the 2012/13 cropping season in three agro-ecologies in central Malawi. CIMMYT started interacting with farmers using CA-based SI technologies since the 2007-2008 cropping season in three agro-ecologies in central Malawi. Mother trials that are at least five years from both MSU and CIMMYT-led activities will be selected for this study.  After a false start with a flawed research design in 2020, data was successfully collected in 2021 with an expanded experimental design, with treatments as follows:   1. Mother trial farmers – at least four mother trials per agroecology, drawn from the long-term trials that are maintained in sub-activity 1.1.1.2 (Investigations on the medium to long term impacts of SI technologies (improved soil fertility management, improved germplasm, crop combinations, nutrient and water management) on crop productivity on multi-locational field sites 2. Mother trial host farms – farm-scale analysis of all the mother trial host farmers from sub-activity 1.1.1.2. At least three yield–cut replications for each of the fields and for each of the crops established on the farm, irrespective of whether the crops are part of the mother trials (this would inform productivity and crop diversity on the farms) 3. Baby farmers: Farm scale analysis of at least eight baby trial host farmers for each site. 4. Local controls: Farm scale analysis of at least eight local control farmers randomly selected from 100s of farmers in the community with no record of directly engaging with Africa RISING, and 5. Distant controls: Farm scale analysis of at least eight distant control farmers randomly selected from 100s of farmers in another distant community (at least 10 km), with similar agro-ecological conditions. These local controls should ideally be in neighboring EPA with a different set of extension workers to minimize any chances of contamination. The difference between IV and V will improve the overall interpretation of the results.   Mother trials are often planted on time, with the best agronomic practices (fertilizer management, appropriate rotations, soybean inoculation with good bacteria strain, weeding, etc.). We hypothesized that crop productivity in mother trials typically represents water-limited yield potential for the different agro-ecologies. In our analysis, these crop yields are used as benchmarks to assess the level of intensification at the farm scale for the four farmers’ groups (II, III IV, and V) (Figure 1).  This activity profiled framers’ technologies and assessed impact at the farm scale. We hypothesized that mother trial farmers are more likely to adopt more technologies as they more closely interact with a range of SI technologies in the mother trials. We investigate whether these farmers with more SI technologies are also more resilient to shocks. Through this sub-activity, we will be able to give feedback on SI technologies and their use firmly anchored on empirical evidence from the detailed whole-farm systems analysis. This would feed into policy discussions. In 2022, we will complete the data analysis and write up for scientific publications and policy discourses.  a  b  c  d  Figure 1. Conceptual framework for assessing the impact of Africa RISING interventions through yield gap analysis and production, for farmers interacting with Africa RISING at different intensity. Yield gap ‘a’ illustrates the difference between optimized use of NP (water-limited yield) and knowledgeable farmer adapted SI, ‘b’ is a function of knowledge intensity gap between mother and baby trial farmers, and ‘c’ is yield non-participating local farmers forfeit, and ‘d’ is the exploitable intensification gap. The y-axis variable is here given as maize but could be any other crop. This analysis is true for farmers in similar resource endowment group. A distant control has been included to better inform the level of local diffusion. | | | | | |
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| 2. Objectives | | | | | |
| 2.1 To determine differentials in farm-scale uptake of SI technologies for mother trial host farmers, baby trial farmers, and farmers not directly participating in Africa RISING activities | | | | | |
| 2.2 To determine the effect of farm typology on the adoption of SI technologies | | | | | |
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| 3. Research questions/hypotheses  This activity will profile farmers’ technologies and assess the impact at farm scale. We hypothesize that: | | | | | |
| 3.1 Mother trial farmers are more likely to adopt more technologies as they more closely interact with a range of SI technologies in the mother trials. | | | | | |
| 3.2 Farmers implementing a range of SI technologies are also more resilient to shocks and have a larger SI index. | | | | | |
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| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | |
| Experiment design, implementation, and data analysis  Crop productivity on mother trials typically represents water-limited yield potential within each of the three agro-ecologies where the study will be carried out (high, medium, and low agroecological potential).  A total of 28 farms in each of the 3 EPAs in central Malawi (Linthipe, Kandeu, and Golomoti) and two sites in southern Malawi (Balaka and Zomba) were selected: 4 mother trial host farmers, eight baby trial farmers, eight non-participating local farmers, and eight distant controls. The study is structured around three modules implemented at appropriate times during 2021, as described below.  *Module 1:* 28 farms in each of the 5 EPAs were characterized in detail from mid-January through February 2021, when the crops were well established. Eight farms were selected randomly from lists of baby farmers, local or distant controls. All farmers were selected in mid-January 2021, after planting had been completed; therefore, the researchers did not unduly influence farmer behavior in any way beyond the usual interaction with them as mother trial host farmers, baby farmers, or farmers who have not directly interacted with Africa RISING (the control farmers). Data was collected on household composition, farm size, and individual fields and cropping for each field. Field sizes were accurately determined through the GPS area determination function. The range of crops established per farm was recorded and will now be used to establish any association between ‘treatment’ and crop diversity index.  *Module 2:* This was implemented during March-May 2021 harvest period. The module is primarily on determination of crop productivity through yields cuts on at least three replicates within each of the fields on a farm or trials.   * + - * On-station mother trials: crop yields were determined in the mother trials, as has been done over the years since trials were implemented. The mother trials are optimally established. The yields from these trials are a good estimate of the potential for the different technologies in different environments. This yield level is ecologically referred to as water-limited yield potential.       * Mother trial on farmers’ farm: crop yields were determined for at least three positions in each field to capture within-field variability       * Baby trial farmers’ whole-farm SI application: Within each EPA, eight baby trial farmers were randomly selected, and crop yields were determined for each of their fields.       * Eight local control farmers: Within each EPA, eight local control farmers were randomly selected, and crop yields were determined for each of their fields.       * Eight distant controls: Distant controls have to be at least 10 km from the intervention site but with similar agroecology to control for climate-induced variations. Crops yields were determined as described for other treatments   In all cases, plant density was determined, and soil samples were taken to relate crop productivity and soil chemical and physical characteristics. For example, where NP fertilized maize is one of the SI technologies in the mother trial, maize yields on NP fertilized maize yields were obtained from the other treatments (farmer categories).  *Module 3:* This was implemented during the post-harvest period to get data on farmer-reported production, marketing, and consumption. The objective is now to link the data from the three modules.  In 2022, we will use a whole farm modeling approach combined with a positive deviant (PD) approach to analyze results from alternative practices adopted by farmers (implementing mother, baby trials, local and distant controls). Positive deviants are defined as individuals that achieve better outcomes than their peers even though they are characterized by the same resources, constraints, and risks; this can be achieved due to innovative use of available assets (Marsh et al., 2004[[42]](#footnote-43); Pant and Odame, 2009[[43]](#footnote-44)). Moreover, adoption is made even easier because these individuals represent examples to the community who are more credible than researchers or other outsiders (Bradley et al., 2009[[44]](#footnote-45)). This activity will provide a holistic assessment of the project effects at farm-household level, based on the combined data from the three modules. The aim is to determine the number and combination of technologies implemented by farmers and quantify farm and household performance in selected productive, nutritional, socioeconomic, and environmental indicators. Positive Deviant farmers will be identified based on Pareto-optimality and above-average performances for the indicators.  Most of the analysis will be done based on the FarmDESIGN model. FarmDESIGN is a whole-farm static model that quantifies farm productivity, economic, and environmental performance annually and includes a multi-objective optimization algorithm (Groot et al., 2012[[45]](#footnote-46)). Therefore, the model can diagnose current farm performance and redesign/explore alternative management. In the exploration process, the model generates alternative configurations of farming systems by adjusting farm components and inputs and evaluating the consequences for productive, economic, and environmental performance, which can serve as constraints or objective variables for optimization. The optimization is performed using a Pareto-based multi-objective Differential Evolutionary (DE) algorithm, which uses the current farm configuration as a starting point (Groot et al., 2010)[[46]](#footnote-47).  The study will use the concept of Pareto optimality to combine multiple objectives without resorting to subjective weighting (Das, 1999[[47]](#footnote-48); Groot and Rossing, 2011[[48]](#footnote-49)). Pareto-optimal or non-dominated solutions are the ones that outperform the other solutions in one or more indicators without being outperformed in any other indicator themselves. Pareto-optimal solutions define the Pareto frontier and describe the solutions performing below the potential optimal level (i.e., suboptimal or dominated solutions). Suboptimal solutions can be still improved in multiple indicators up to the Pareto frontier and, therefore, represents the scope of improvement within the population (Modernel et al., 2018[[49]](#footnote-50)) | | | | | |
|  | | | | | |
| 5. Data (with metrics) to be collected and uploaded on Dataverse | | | | | |
| Data for the SI indicators presented here has largely been collected. More data will be collected for no more than 25% of the farmers that were surveyed during 2021, with positive defiant households purposively selected. | | | | | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method | Responsible | | Productivity | | | | | |  | | *Grain productivity* | Maize and legume grain yield (kg/ha/season); | total farm production (kg/ha/farm) |  |  | Yield measurements | MSU | | *Biomass productivity* | Maize and legume grain and biomass yield (kg/ha/season |  |  |  | Yield measurements | MSU | | *Yield gap* | Yield gap for maize and grain legumes (kg/ha/season) |  |  |  | Yield measurements | MSU | | Economic | | | | | |  | | *Profitability* | Net income ($/crop/ha/season);  Gross margin |  |  |  | Survey | IITA/MSU | | Environmental | | | | | |  | | *Soil biology* | Soil organic carbon (g/kg) |  |  |  | Laboratory analysis | MSU | | *Soil chemical quality* | Biological N2-fixation (kg/ha) | Biological N2-fixation(kg/farm) |  |  | Direct measurement | MSU | | Human condition |  |  |  |  |  | MSU | | *Nutrition* | Protein production (g/ha); |  |  |  | Lookup tables | MSU | | *Food security* | Food production  (calories/ha/year) |  | Months of food insecurity |  | Lookup tables, survey | MSU | | Social | | | | | |  | | *Gender equity* | Rating of technologies by gender |  |  |  | Participatory evaluation | MSU | | *Social cohesion* |  |  | Participation in community activities |  | Focus group discussions |  | | | | | | |
|  | | | | | |
| 6. Deliverables | | | Means of verification | Delivery date | |
| 6.1 ‘Outlier farms’ revisited, and detailed farm profiles documented (about 25% of 2021 farms) | | | Data collected from Module 1 | Feb. 2022 | |
| 6.2 Estimates of yield gaps; farm scale SI scaling for ‘outlier farms’ [both laggards and positive deviant households] | | | Excel files, raw field data (Module 2) | May 2022 | |
| 6.6 Data analysis, synthesis, and scientific publication in an appropriate agricultural systems journal | | | Submitted manuscript | Aug. 2022 | |
| 6.3 Data combined and uploaded on Dataverse | | | Data files, reports | Aug. 2022 | |
|  | | | | | |
| 7. How will scaling be achieved? | | | | | | |
| Scientific publication in an appropriate agricultural systems journal for wider dissemination to the scientific community | | | | | | |
|  | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | |
| Mother and baby trials were chosen from work implemented by MSU and CIMMYT | | | | | | |

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| 9. Gantt chart | | | | | | | | | | |
| Year/month | 2021 | | 2022 | | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| IITA –MSU contract/inputs distribution |  |  |  |  |  |  |  |  |  |  |
| MSU/partners contracting |  |  |  |  |  |  |  |  |  |  |
| Outlier farms (laggards and positive deviants) profiling for case studies (Module 1) |  |  |  |  |  |  |  |  |  |  |
| Outlier Yield data collection on cases study farms/harvesting Module 2) |  |  |  |  |  |  |  |  |  |  |
| Dataverse data upload |  |  |  |  |  |  |  |  |  |  |
| Synthesis of data; Report writing/publications |  |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | | | | | | |
| a. Output 5.1 | | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | | | | | |
| b. Activity 5.1.1 | | Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations | | | | | | | |
| c. Sub-activity 5.1.1.5 | | Panel survey, soils processing, and meta-analysis studies for maize-grain legumes sequences and implications for sustainability | | | | | | | |
|  | | | | | | | | | |
| d. Research team | | | | | | | | | |
| Name | | Institution | | | Role | | | | |
| Regis Chikowo | | MSU | | | PI, study conceptualization, data collation, data analysis, and synthesis, and contribute to the publication | | | | |
| Sieg Snapp | | MSU | | | Study conceptualization and synthesis and contribute to the publication | | | | |
| MSU economist | | MSU | | | Data analysis and synthesis and contribute to the publication | | | | |
|  | | | | | | | | | |
| e. Student(s): Nil | | | | | | | | | |
|  | | | | | | | | | |
| f. Location(s) | | Data from all sites in Malawi | | | | | | | |
|  | | | | | | | | | |
| g. Start date | | November 2021 | | | | | | | |
|  | | | | | | | | | |
| h. End date | | August 2022 | | | | | | | |
|  | | | | | | | | | |
| 1. Justification | | | | | | | | | |
| This sub-activity is integrative, aiming to pool data generated from different activities since the inception of Africa RISING. Data sources include field experimentation and panel surveys. MSU implemented surveys, tracking 600 farmers during 2013 (baseline), 2014, and yearly after that. The panel surveys are now an invaluable source of repeated observations derived by following a sample of households over time and collecting data from a sequence of interviews. This panel survey is critical for collecting farmer opinions and practices, potentially useful information for better targeting technologies, and more informed decision making. For example, farmers have been trained on the appropriate use of nutrient resources, ecologically sound crop sequencing, and water management, among other technologies. We followed each of the farmers tagged with unique household IDs during each of these surveys. More importantly, we estimated crop productivity for two field types for each farm: the rich and poor fields as perceived by each panel household. Enumerators performed yield cuts on three net plot areas within each field. It is important to measure the farmers’ progress. The obvious variable of choice was crop productivity. However, soil organic carbon, a slow-changing attribute of soil, which is regarded as one of the most important indicators of soil health and sustainability, was also quantified. We recognize that the vast data sets can be analyzed from different angles and now seek to tap into the different expertise of Africa RISING researchers.  There are interventions that the Malawi government is implementing that need more analysis in terms of sustainability. In particular, farm input subsidies are African countries' main pro-poor development policies, with Malawi’s case of inorganic fertilizers, improved maize, and legume seeds taunted as a success story (Arndt et al., 2016)[[50]](#footnote-51). However, recent studies show that dependence on subsidies affects the agency of the ultra-poor to invest in sustainable soil fertility management strategies (Mponela, 2020)[[51]](#footnote-52) , and the conventional farming that the policy promotes leads to land degradation (Messina et al., 2017)[[52]](#footnote-53).  The FarmDESIGN module will be calibrated using data, models, and parameters generated from trials and surveys by the Africa-RISING project. The work will address the sustainability question: What are the farm-specific multi-domain impacts of subsidized fertilizer, legume integration, and/or organic recycling on social (technology adoption), economic (crop production), and environmental (soil nutrient balances) outcomes? This could be carried forward by policy-related institutes such as Mwapata, an independent agricultural policy think tank in Malawi, engaging the Government of Malawi, private sector, and civil society stakeholders in applied policy analysis and policy outreach capacity building and policy coordination. | | | | | | | | | |
|  | | | | | | | | | |
| 2. Objectives | | | | | | | | | |
| 2.1 Work with economists to finalize synthesis and publications based on large data sets from the panel surveys | | | | | | | | | |
| 2.2 To relate SOC data from long-term controlled experiments and SOC from farmer fields based on the extension services use of the hand-held Soil C reflectometer as part building capacity for soil health indicators measurements, for an Africa RISING legacy in extension services. | | | | | | | | | |
| 2.3 To complete meta-analysis on data from mother trials implemented over multi-locations and years and provide data for calibrating the FarmDESIGN module | | | | | | | | | |
|  | | | | | | | | | |
| 3. Research questions | | | | | | | | | |
| Meta-analysis study: Several research questions will now be answered based on a large data set from more than 40 mother trials that were established in Malawi for over nine years. Key questions to investigate for the meta-analysis include: | | | | | | | | | |
| 3.1 How does mother trial data inform better targeting of legume diversification? In particular, legume crops have been promoted for poorer and vulnerable populations – but are benefits consistent in marginal environments? | | | | | | | | | |
| 3.2 Which SI system is nutritionally superior to other systems in terms of protein produced and calories across agro-ecologies? | | | | | | | | | |
| 3.3 What is the magnitude of stability enhancement in cropping systems that integrate water management practices? | | | | | | | | | |
| 3.4 What are the farm-specific multi-domain impacts of subsidized fertilizer, legume integration, and/or organic recycling on social (technology adoption), economic (crop production), and environmental (soil nutrient balances) outcomes? | | | | | | | | | |
|  | | | | | | | | | |
| 4. Experiment design, implementation, and data analysis | | | | | | | | | |
| 4.1 Panel surveys (repeated measurements from households over time) have already generated data. Different sets of skills for data analysis will unravel hidden trends in the data | | | | | | | | | |
|  | | | | | | | | | |
| 5. Data (with metrics) to be collected and uploaded on Dataverse  Note: Data already exists from field experiments and surveys | | | | | | | | | |
| SI Domains & *Indicators* | Field/Plot level metrics | | Farm level metrics | | Household level metrics | Community/landscape metrics | Measurement method | | Responsible |
| Productivity | | | | | | | | | |
| *Maize grain productivity* | Maize grain yield (kg/ha/season); | | Maize production (kg/ha | |  |  | Yield measurements | | MSU |
| *Legume grain productivity* | Legume grain yield (kg/ha/season | | Legume production (kg/ha/season) | |  |  | Yield measurements | | MSU |
| Human condition | | | | | | | | | |
| *Nutrition* | Protein production (g/ha); | | Protein production (g/ha); | | Availability of diverse food crops; Dietary diversity; | Availability of diverse food crops; | Surveys;  Laboratory testing | | MSU |
| *Food Security* |  | |  | | Food availability,  Food utilization  composite index, |  | Surveys, | | MSU |
| Economics | | | | | | | | | |
| *Profitability* | Net income ($/crop/ha/season); | |  | |  |  | Survey | | IITA |
| *Income diversification* |  | |  | | Number of income sources |  | Survey | | IITA |
| Social NA | | | | | | | | | |
| Environment | | | | | | | | | |
| *Soil biology* | SOC content (g/kg) | | SOC content (g/kg) | |  |  | Laboratory | | MSU |
| *Soil chemical quality* | Biological N2-fixation | |  | |  |  |  | | MSU |
|  | | | | | | | | | |
| 6. Deliverables | | | | Means of verification | | | | Delivery date | |
| 6.1 Develop a legacy document on SI interventions as a basis for advocacy | | | | Policy brief on SI strategies in the context of the Government input subsidy program | | | | May 2022 | |
| 6.2 Meta-analysis data | | | | Manuscript led by Julius Manda on Panel survey | | | | Jul. 2022 | |
| 6.3 SOC stocks quantified for long-term experiments; farm scale SOC estimated through simple reflectometers | | | | Manuscript led by Chikowo (SOC long-term experiments; SOC reflectometer advisory services and efficiencies on farms | | | | Aug. 2022 | |

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| 9. Gantt chart | | | | | | | | | | |
| Year/month | 2021 | | 2022 | | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| IITA –MSU contract/inputs distribution |  |  |  |  |  |  |  |  |  |  |
| Meta-data compilation/analysis |  |  |  |  |  |  |  |  |  |  |
| SI analytical tool will be developed and calibrated |  |  |  |  |  |  |  |  |  |  |
| Report writing/publications |  |  |  |  |  |  |  |  |  |  |
| Dataverse data upload |  |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| a. Output 5.1 | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | |
| b. Activity 5.1.2 | Use farm trial data to apply crop simulation models and assess performance over space and time, including assessment of climate-smart technologies to establish the potential for adaptation and mitigation | | | |
| c. Sub-Activity 5.1.2.1 | Apply APSIM crop simulation model to assess changes in resource use efficiencies, productivity, and profitability of the different cropping systems in Kongwa, Kiteto, and Iringa in Tanzania | | | |
|  | | | | |
| d. Research team | | | | |
| Name | Institution | Role | | |
| James Mwololo | ICRISAT | PI | | |
| Anthony Whitbread | ICRISAT | Coordinate modeling work within ICRISAT for data sets for cross country data sets, support drafting of paper generated from the studies | | |
| Sieglinde Snapp | MSU | Coordinate modeling work involving the Malawi activities and support drafting of papers generated from the studies | | |
| Amos Ngwira | ICRISAT | Complete the APSIM modeling work based on regional data sets (Malawi and Tanzania), engage with other Africa RISING agronomists for cross-site studies to draft papers | | |
| Daniel Mgalla | IITA | M&E support | | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s)  District, Village | Kongwa District, Villages-Chitego, Mlali, Laikala, and Moleti; Kiteto District- Villages-Njoro or Kiperesa | | | |
|  |  | | | |
| g) Start date | November 2018 | | | |
|  |  | | | |
| h. End date | July 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| Simulations conducted in the Agricultural Production Systems Simulator (APSIM) from 2011 to 2019 rainfall and agronomic data from on-farm trials and parameterized in APSIM show for these semi-arid ecologies that precipitation is a big driver of crop performance. During this period, we will complete two main studies, all based on APSIM modeling. First, using the data already available for Tanzania and Malawi for modeling. The Malawi data is analyzed and what remains is the completion of modeling using the Tanzania data. Once completed, these studies will inform technology deployment for de-risking smallholder production in dryland ecologies such as central Tanzania and Malawi.  Additionally, from the on-station and on-farm experiments (activities of 5.1.1.2), data will be assembled for the cereal legume intercrop systems involving pigeonpea and sorghum (third season) and or maize (second season). This data includes yield-grain, biomass, and crop phenology. Data already assembled - soil-water characteristics, bulk density, and % soil organic matter - will be used, along with data obtained from NASA power on temperature and solar radiation of each study site. All data will be handled as previously described in the 2019-2020 ICRISAT- SUA workplan and budget. The key results informing the proposed work are:   1. Yield losses in pigeonpea-sorghum intercropping are 33% for sorghum under intercrop and up to 74% for pigeonpea. In both cases, intercropping compensates for the yield, albeit with lower land equivalent ratios compared to high potential sub-ecologies in these drylands’ ecologies. For very constrained environments such as Laikala, where intercropping is useful as is commonly practiced by farmers, the benefits are tapered by annual precipitation. Earlier, we reported that simulated grain yield for cereals (sorghum and pearl millet) and legumes (pigeonpea and groundnut), approximated observed yields, indicative of APSIM’s ability to predict cereal responses to intercropping. Completing the modeling assignment will generate information on the implications of sustainable intensification options on climate and market risks and resource use efficiency by smallholder agriculture, especially in drylands. 2. Across study sub-agroecologies for legume-legume systems, crop phenology plays a major role, especially the fit to specific cropping systems. For example, the medium duration (groundnut) and long duration (pigeonpea), are suitable only for high potential sub-agroecologies. In the cereal-legume system established in low potential sub-agroecologies, e.g., Igula, Iringa, and Laikala, pigeonpea grain yields are reduced by up to 35%, especially when sorghum is intercropped with long duration pigeonpea, again suggesting an effect of varietal phenology. The modeling work, when completed, will inform the optimization of production and resource management in these constrained environments cereal-based systems. 3. The modeling work will also clarify the resource use efficiency. For example, in pigeonpea and groundnut doubled-up cropping system, simulated results show that the faster-establishing groundnut uses relatively larger quantities of available water resources, especially under drought, before the slow-establishing pigeonpea, resulting in reduced pigeonpea yields, especially in long-duration material. Thus, productivity can inadvertently be affected by crop and variety compatibility. 4. Total soil organic C simulated in the top 15 cm of soil increased throughout our study (1980-2019), especially when pigeonpea was added to the cropping system signifying the importance of grain legumes in sequestering soil C and the eventual sustainability of the cropping systems. Further experimentation and validation of these findings are needed to inform the utilization of appropriate management systems for intercrops that enhance productivity and farming household resilience. | | | | |
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| 2. Objectives | | | | |
| 2.1 To complete APSIM modeling of doubled-up legume at regional level (Malawi + Tanzania) enabling the prediction of yields of improved groundnut and pigeonpea under varied agro-ecologies through on-farm experimentation | | | | |
| 2.2 To complete APSIM modeling of Cereal-legume intercropping systems at the regional level (Malawi + Tanzania) enabling prediction of the yields of improved and resilient cereals (Sorghum) and legumes-pigeonpea under varied agro-ecologies through on-farm experimentation | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1 To what extent does the APSIM model predict the performance of doubled-up legume and cereal-legume intercrop systems under central Tanzania's stressed and moderately stressed environments? | | | | |
| 3.2 What is the long-term implication of using improved drought-tolerant varieties in minimizing climate and market risks in the face of increased weather variability? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| Experiment design, implementation, and data analysis  Experiments were established in three sub-agro-ecologies (same as for 5.1.1.2) in Tanzania, using the mother-baby trial approach. The mother trials are research control sites where optimal agronomy is ensured. The babies are farmer-managed trials, the genetics controlled by giving farmers the same varieties, but whose management may vary. This way, we will be able to capture data across a broad spectrum of production conditions in the semi-arid ecologies of central Tanzania. It should be noted that most baby-trial hosts are members of community seed banks trained on good agronomy.  In Malawi, a similar setup of the mother-baby trial approach will be used to establish experiments in two sub ecologies, i.e., lowland agroecology, i.e., (200-500 meters above sea level, usually in the dryland system) that receives less than 600 mm of rainfall annually; and the mid-altitude agroecology (501-1,300 meters above sea level), that receives less than < 800 mm of rainfall annually. The low land agroecology is similar to the constrained sub-agroecology of Kongwa and Kiteto, while the mid-altitude is similar to the high potential sub-agroecology.  Using this arrangement, the research team will create scenarios to assess the efficacy of sustainable intensification options on climate and market risks and the resource use efficiency of smallholder agriculture. These scenarios include Grouping cropping systems into climate variability, agro-ecological zones, soils, and management practices. The calibrated model for the legume-legume (already done in Malawi and partially for Tanzania data respectively) will be used. Long-term simulations using long-term climatic data obtained from NASA will be used for the simulations. This effort will lead to the assessment of changes in the resource base, resource use efficiencies, productivity, and profitability of the different cropping systems in central Tanzania. | | | | |
|  | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method (details in research protocol) | | Productivity |  |  |  |  |  | | *e.g., Crop (Pearl* millet, sorghum, pigeonpea and groundnut*) productivity* | Yield (kg/ha/season) | Yield (kg/ha/season) |  |  | Yield measurement | | *e.g., Crop (Pearl* millet, sorghum, pigeonpea, and groundnut*) biomass productivity* | Residue production (kg/ha/season) | Residue production (kg/ha/season) |  |  | Yield measurement | | *Variability of production* | Coefficient of variability  Probability of low productivity | Coefficient of variability  Probability of low productivity |  |  | Productivity over time | | Economic |  |  |  |  |  | | *Profitability* | Net income ($/crop/ha/season) | Net income (Total net income for all farm activities) |  |  | Participatory Evaluation | | Environmental |  |  |  |  |  | | *Fuel availability* | Fuel biomass (residuals)/plot | Fuel biomass (residuals)/farm |  |  | Biomass measurement | | *Water availability* | % of plants wilting | % of fields wilting |  |  | Field tests | | *Soil biology* | Total carbon (%) |  |  |  | Computer modeling | | | | | |
|  | | | | |
| 6. Deliverables | | | Means of verification | Delivery date |
| 6.1 Long-term implications of intercropping systems on climate and market risks and resource use efficiency of smallholder farms assessed | | | Manuscript | Mar. 2022 |
| 6.2. Meta-analysis of doubled-up legume systems as well as maize-pigeonpea intercropping | | | Manuscript | Jun. 2022 |
|  | | | | |
| 7. How will scaling be achieved? | | | | |
| The main beneficiary of this sub-activity is the scientific community which will, through publications, gain better insights into appropriate intervention strategies that increase resource use efficiencies, productivity, and profitability while reducing production risk. | | | | |
|  | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | |
| The modeling outputs will inform better intervention strategies for doubled-up legumes, cereal-legume intercrops implemented by the Africa RISING community, including ICRAF, TARI-Makutupora, and SUA (integrated soil fertility management), MSU-Malawi and ICRISAT NARS of Malawi. We will also work with the Systems agronomist (IITA) and Malawi's Michigan State University team. | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 9. Gantt chart | | | | | | | |
| Year/month | 2021 | 2021 | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun |
| Manuscript development: Long-term implications of intercropping systems |  |  |  |  |  |  |  |
| Manuscript development: Meta-analysis of doubled-up legume systems |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| a. Output 5.1 | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | |
| b. Activity 5.1.2 | Use farm trial data to apply crop simulation models (APSIM) and assess performance over space and time, including assessment of climate-smart technologies to establish the potential for adaptation and mitigation | | | |
| c. Sub-Activity 5.1.2.2 | Evaluate the potential contributions of integrated soil-fertility management around the five SIAF domains with emphasis on Africa RISING interventions in Tanzania | | | |
|  | | | | |
| d. Research team | | | | |
| Name | Institution | Role | | |
| Job Kihara | CIAT | PI | | |
| Jonas Julius  Rose Anael | MoA | Co-development of success stories, capturing perspectives from district extension  Identify stakeholders, manage invitations and organize district-wide policy forum | | |
| Jonathan Odhong  Eveline Massam | IITA | Identify high-quality video capture and editing team, and confirm the quality of output  Participate in the district-wide forum to capture and communicate the event proceedings | | |
|  | | | | |
| e. Student(s) | | | | |
| Name | Institute | Degree | Start | End |
| Michael Kinyua | CIAT/Kenyatta University | PhD | 2019 | 2022 |
|  | | | | |
| f. Location(s) | Long, Seloto, Sabilo, Gallapo, Riroda, Hallu in Babati District, Tanzania | | | |
|  |  | | | |
| g. Start date | |  | | --- | | December 2018 | | | | |
|  |  | | | |
| h. End date | August 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| Africa RISING had several successes, including fertilizer microdosing, lablab, and cowpea as cover crops, water harvesting, new varieties, Mbili Mbili, toppings and strippings, extension services demonstrations, and partnerships with the private sector. This activity is to develop these successes into specific stories in a compendium (in English and Swahili) and communicate those through various media, specifically district-level key stakeholder/policy forums, etc. This activity will also develop ISFM implementation brief/technology label, including benefits derived from specific ISFM components. | | | | |
|  | | | | |
| 2. Objectives | | | | |
| 2.1. Capturing key voices on ISFM implementation successes from farmers (at least ten farmers) around which a specific storyline will be developed. One of such farmers (Albert Edward Shayo) was jumpstarted by fertilizers and quickly transitioned to dig a well for irrigating vegetables). Short videos for some of the 10 farmers (where deemed necessary) will be captured for further communication. | | | | |
| 2.2 Compendium of success stories (English and translated to Swahili) including 1) application of Mbili-Mbili and its adaptation by farmers, 2) uptake of fertilizer use, especially in the highlands, this has implications of strengthening overall system productivity as evidenced by the nutrient flows across slope gradients that we submitted for publication; 3) use and market share of new, improved varieties introduced by Africa RISING, 4) Priscas’s Mbili Mbili with maize, cassava, and beans, 5) improved plant spacing including the example of one farmer doing 17 acres for maize in Gallapo 6) Selian 11 the cover crop bean demonstrated in climate-smart practices where it is producing biomass over an extended period, besides grains. | | | | |
| 2.3. Hold district-level key stakeholder/policy forum to deliver the key messages and share the compendium with key actors in Swahili | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1 What are the key messages arising from Africa RISING work, and what success stories will deliver those to farmers and other key stakeholders in Babati and beyond? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| First, a list of all potential success stories will be assembled, reviewing the previous CIAT progress reports and adding what the team knows from the ground. For those deemed best in communicating and spreading the message, draft stories will be developed based on what the team knows and supplemented with phone calls where necessary to the farmers themselves or related extension staff.  Secondly, and at the same time, scientific findings that support the stories, e.g., fertilizer uptake, variety penetrations/market share since 2013, ISFM benefits, etc., will be synthesized using the available data. Graphs or Tables with specific synthesized messages will be added to the story text.  Thirdly, a follow-up visit will be made to the specific farmers, where specific aspects of the success stories and farmer perspectives will be captured. These will be integrated into the stories, and all of these will be put together into a compendium. The compendium will be designed into a high-quality booklet to be made available to specific offices and stakeholders during the stakeholder/policy forum.  Fourth, video recording sessions will be made involving project farmers, extension staff, other farmers in the neighborhood, and involved scientists, among others, depending on the specific case. The videos will capture key messages from the different teams/people involved. While some of the recordings will be done in the field, others will be done in the office, zooming into specific graphs and decision trees to explain findings. | | | | |
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| 5. Data to be collected and uploaded on Dataverse  No new data will be collected. The stories, however will cover aspects from all the five SIAF domains. | | | | |

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| Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape level metrics | Measurement method (details in research protocol) |
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| 6. Deliverables | Means of verification | Delivery date |
| 6.1 ISFM components and benefits brief | Technology label | May 2022 |
| 6.2 Compendium of success stories in English and Swahili | Compendium | Jun. 2022 |
| 6.3 Two short YouTube videos communicating key stories and findings | YouTube recordings | Aug. 2022 |
| 6.4. Analysis of organic resources transfers and interactions with landscape positions influence crop yields among smallholder farmers in northern Tanzania | Draft journal article (on previous budget) | Aug. 2022 |
| 6.5. Summary of Participatory action research, social networks, and gender influence soil fertility management in Northern Tanzania | Draft journal article (on previous budget) | Aug. 2022 |
| 6.6. Analysis of understanding the potential contributions of Integrated Soil fertility management to various sustainable intensification impact domains | Draft journal article (on previous budget) | Aug. 2022 |
| 6.7. Farmer and extension guide in English and Swahili translation | Field implementation guide (on previous budget) | April 2022 |
|  | | |
| 7. How will scaling be achieved? | | |
| The stories, video recordings, and the compendium will be freely available online for use by anyone. These will also be put in the hands of key stakeholders and policymakers operating within the Babati district (and some also from outside the district when deemed necessary) so that these stakeholders can scale them out. These products, together with the developed field guide can be presented during Nane Nane agricultural exhibition. We will also utilize Mwanga ICT platform to communicate agronomic information. Also, we already have a strong partnership with Meru-Agro and the Mingingu fertilizer company, which could continue the scaling of these products. | | |
|  | | |
| 8. How are the activities in this protocol linked to those of others? | | |
| This work strongly builds on activities of Africa RISING teams in Babati since 2012. Any success stories from any of the teams can also be included in the compendium. | | |
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| 9. Gantt chart | | | | | | | | | |
| Year/month | 2021 | 2022 | | | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Identification of potential success stories and key farmers to capture |  |  |  |  |  |  |  |  |  |
| Drafting of success stories |  |  |  |  |  |  |  |  |  |
| Scientific synthesis for data (tables and graphs) to accompany specific success stories |  |  |  |  |  |  |  |  |  |
| Finalization of success stories and scientific editing |  |  |  |  |  |  |  |  |  |
| Translations of success stories into Swahili |  |  |  |  |  |  |  |  |  |
| Development of a compendium of success stories, enriched with other results not necessary in the stories |  |  |  |  |  |  |  |  |  |
| Identification of video storylines and outlines of scripts, and potential shooting locations |  |  |  |  |  |  |  |  |  |
| Video capture, editing, and publications |  |  |  |  |  |  |  |  |  |
| Preparations of materials for the district level policy forum |  |  |  |  |  |  |  |  |  |
| District-level policy forum |  |  |  |  |  |  |  |  |  |
| 2 bi-annual reports |  |  |  |  |  |  |  |  |  |

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| Project Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| a. Output 5.1: | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | |
| b. Activity 5.1.2: | Use farm trial data to apply crop simulation models and assess performance over space and time, including assessment of climate-smart technologies to establish the potential for adaptation and mitigation | | | |
| c. Sub-activity 5.1.2.3: | Synthesizing information, knowledge, and tools Africa RISING - ESA has generated over its lifetime (10 years) guided by the Sustainable Intensification Assessment Framework (SIAF), which has been central to informing the benefits and trade-offs during the implementation of different activities. Following SIAF, five teams will work in different SIAF areas. | | | |
|  | | | | |
| d1. Team A: Soil Organic Carbon (SOC) | | | | |
| Name | Institution | Role | | |
| Sieglinde Snapp | MSU | Research | | |
| Regis Chikowo | MSU | Research and Synthesis | | |
| Christain Thierfelder | IITA | Research and Synthesis | | |
| Lieven Claessens | IITA | Synthesis | | |
| Job Kihara | CAT | Synthesis | | |
| Cheryl Palm | Florida University | Coach SOC team | | |
|  |  |  | | |
| d2. Team B: Farmers’ access to seeds and technologies: Innovations in enabling farmers to take up practices and access quality seeds | | | | |
| Sieglinde Snapp | MSU | Coach Team B | | |
| Phil Grabowski | Taylor University | Coach Team B | | |
| Julius Manda | IITA | Synthesis | | |
| Rosina Wanyama | WorldVeg | Synthesis | | |
| Sognigbe Ndanikou | WorldVeg | Synthesis | | |
| James Mwololo | ICRISAT | Synthesis | | |
| Patrick Okori | ICRISAT | Synthesis | | |
| Douglas Slater | MSU | Synthesis | | |
|  |  |  | | |
| d3. Team C: Linking human, plant, and soil nutrition: Field crop and vegetable system technologies that enhance the nutrition of humans, plants, animals, and soils | | | | |
| Phil Gabrowksi | Taylor University | Coach Team C | | |
| Regis Chikowo | MSU | Synthesis | | |
| Agnes Mwangwela | LUANAR | Synthesis | | |
| Job Kihara | Alliance Bioversity CIAT | Synthesis | | |
| Douglas Slater | MSU | Synthesis | | |
|  |  |  | | |
| d4. Enhancing biodiversity, agroforestry, shrubby legume, and crop diversity | | | | |
| Alexia Witcombe | MSU | Coach Team D and research | | |
| Regis Chikowo | MSU | Research plus synthesis | | |
| Christian Thierfelder | CIMMYT | Synthesis | | |
| Francis Muthoni | IITA | Synthesis | | |
| Job Kihara | Alliance Bioversity CIAT | Synthesis | | |
| Elizabeth Ngadze/ Casper Kamutando | University of Zimbabwe | Research | | |
| Sieglinde Snapp | MSU | Research | | |
|  |  |  | | |
| d5. SIAF expansion to be more participatory and responsive to social sciences, especially gender awareness | | | | |
| Gundula Fischer | IITA | Coach Team E | | |
| All Africa RISING scientists |  | Synthesis | | |
|  | | | | |
| e. Student(s): UZ MSc – Microbiology | | | | |
|  | | | | |
| f. Location(s): | All Africa RISING East and Southern Africa locations | | | |
| g. Start date | October 2021 | | | |
|  | | | | |
| h. End date | August 2022 | | | |
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| 1. Justification | | | | |
| Africa RISING has generated a lot of information, data, knowledge, and tools during its ten-year lifetime. During the latter half of implementing Africa RISING, the Sustainable Intensification Assessment Framework (SIAF) has been central to informing the benefits and trade-offs during the implementation of different activities. Thus, as much as possible, the arguments for this sub-activity will be guided by SIAF’s five SI domains. This sub-activity will be informed by Africa RISING literature, data and broadened with literature beyond that of Africa RISING. As part of the development of this sub-activity, we have identified some missing information, knowledge, and tools that Africa RISING ESA did not generate. We will generate that information in the short-term through research activities (labeled Part 2). | | | | |
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| 2. Objectives | | | | |
| This sub-activity is different from the others since it concerns synthesis work and, in some cases, additional research. The general objective is to pull together all data, knowledge, information, and tools related to the 5 SIAF domains. For more specific information, kindly see the Annex at the end of this workplan | | | | |
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| 3. Research questions: see the Annex | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
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| 5. Data (with indicators and metrics) to be collected and uploaded on Dataverse | | | | |
| The data are collected for the specific sub-activities and will be uploaded for these sub-activities | | | | |
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| 6. Deliverables: | | | Means of verification | Delivery date |
| 6.1 Report on SOC sequestration potential for different cropping systems and climate change adaptation and research gaps in line with the SIAF (team A) | | | Manuscript draft (Regis (Chikowo/Christian Thiefelder et al.) | Aug. 2022 |
| 6.2 SOC stocks and pools quantified for different cropping systems (team A) | | | Data files, raw data, processed data  (Chikowo/Christian Thiefelder et al.) | Jul. 2022 |
| 6.3 The SIAF environmental domain completed with carefully measured empirical data on SOC for different technologies (team A) | | | Analyzed soils and SOC concentration | Jul. 2022 |
| 6.4 Manuscript, possibly for one of the ‘Nature’ journals on SOC sequestration potential (team A) | | | Manuscript -(Chikowo/Christian Thiefelder et al.) | Aug. 2022 |
| 6.5 Report on the seed systems research gaps for CG space in line with the SIAF (team B) | | |  | Aug. 2022 |
| 6.6 Manuscript on farmers’ access to seeds and technologies: Innovations in enabling farmers to take up practices and access (team B) | | | Manuscript  Grabowski, Slater, Okori et al | Aug. 2022 |
| 6. 7 The final product will be a report that will be turned into a journal article manuscript with a focus on how future research in East Africa on soil–plant–human nutrition could best be designed to contribute to sustainable development (team C) | | | Technical report/Journal article | Aug. 2022 |
| The final product will be a report on the contribution of the Africa RISING approach to enhancing biodiversity in the ESA region (team D) | | | Synthesis report -Kamutando | Aug. 2022 |
| 6. 8 Catalogue of fungi and bacteria found in the soils from different treatments (team D) | | | Report microfauna profiles -Ngadze | Aug. 2022 |
| 6.9 Draft manuscript on biodiversity as a function of long-term SI interventions for publication (team D) | | | manuscript draft –Ngadze, Kamutando, Chikowo | Aug. 2022 |
| 6. 10 Virtual workshop (team E) | | | Proceedings of meeting- Gundula | Jun. 2022 |
| 6.11 An updated book with the two pdfs will be prepared to be published in a format that is widely accessible and provides guidance for multidisciplinary teams engaged in sustainable agriculture development, both to plan and to synthesize research in a stakeholder-engaged and iterative manner, to support the development of new knowledge, farmer-adoptable innovations and the local adaptive capacity (team E) | | | Updated SIAF framework -Gundula | Aug. 2022 |
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| 7. How will scaling be achieved? NA | | | | |

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| 8. How are activities in this protocol linked to those of others? |
| This concerns a synthesis activity that is related to all other sub-activities. |

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| 9. Gantt chart | | | | | | | | |
| Year/month | 2022 | | | | | | | |
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Team A: SOC gains | | | | | | | | |
| Review of literature |  |  |  |  |  |  |  |  |
| Document technologies tested at different sites |  |  |  |  |  |  |  |  |
| Report on SOC sequestration potential for different cropping systems |  |  |  |  |  |  |  |  |
| Soil sampling 3 MSU +3 CIMMYT sites |  |  |  |  |  |  |  |  |
| Soils send to MSU/Analysis |  |  |  |  |  |  |  |  |
| Manuscript development/draft available |  |  |  |  |  |  |  |  |
| Team B: Farmer access to seeds and technologies | | | | | | | | |
| Systematic literature review and meta-analysis conducted to identify the existing research gaps in the cereal, legume, and vegetable seed systems |  |  |  |  |  |  |  |  |
| Conduct a stakeholders’ analysis with the view of identifying strategic partners who can invest in and deliver quality seed of legumes, vegetables, and dryland cereals. |  |  |  |  |  |  |  |  |
| Report on the seed systems research gaps in line with the SIAF |  |  |  |  |  |  |  |  |
| Manuscript |  |  |  |  |  |  |  |  |
| Team C: Linking human, plant and soil nutrition | | | | | | | | |
| Synthesize research lessons from Africa RISING East Africa, at each phase (soil, plant, human). |  |  |  |  |  |  |  |  |
| Conduct literature review, focusing on iron, zinc, and selenium. |  |  |  |  |  |  |  |  |
| Final product will be a report that can be turned into a journal article with a focus on how future research in East Africa on soil–plant–human nutrition could best be designed to contribute to sustainable development. |  |  |  |  |  |  |  |  |
| Team D: Enhancing biodiversity | | | | | | | | |
| Document technologies tested and impact on cropping diversity (agroforestry, grain legumes, CA systems) |  |  |  |  |  |  |  |  |
| Distill data from farm surveys to understand the Africa RISING impact on biodiversity |  |  |  |  |  |  |  |  |
| Soil sampling from MSU long term trials for microbial studies |  |  |  |  |  |  |  |  |
| Lab-based profiling of microbial populations – use simple methods only (advanced methods may require much more time and resources) |  |  |  |  |  |  |  |  |
| Catalog of fungi and bacteria found in the soils from different treatments |  |  |  |  |  |  |  |  |
| Draft manuscript for publication |  |  |  |  |  |  |  |  |
| Team E: SIAF expansion to be more participatory | | | | | | | | |
| Development of a draft write-up to be integrated into SIAF booklet |  |  |  |  |  |  |  |  |
| Virtual workshop to generate feedback and discussion on draft |  |  |  |  |  |  |  |  |
| Finalization of draft for inclusion in SIAF booklet |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | | | | | |
| a. Output 5.1 | | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | | | | |
| b. Activity 5.1.6 | | Disseminate best-fit integrated crop-livestock technologies to reach and have effect on small-scale farmers in a landscape context | | | | | | |
| c. Sub-activity 5.1.6.1 | | Small-scale piloting of FarmMATCH – a framework for typology-based targeting and scaling of agricultural innovations. (Matching Agricultural Technologies to Farms and their Context | | | | | | |
|  | | | | | | | | |
| d. Research team | | | | | | | | |
| Name | | | | | Institution | Role | | |
| Jeroen Groot | | | | | WUR | Farming systems analysis (Activity Leader) | | |
| Francis Muthoni | | | | | IITA | GIS specialist | | |
| Beliyou Haile | | | | | IFPRI | Economic analysis | | |
| Lieven Claessens | | | | | IITA | Farming systems analysis | | |
| Carlo Azzarri | | | | | IFPRI | Economic analysis | | |
|  | | | | | | | | |
| e. Student(s): Nil | | | | | | | | |
|  | | | | | | | | |
| f. Locations | Tanzania (Babati, Kongwa, Kiteto) and Malawi (Dedza, Ntcheu) | | | | | | | |
|  | | | | | | | | |
| g. Start | 1/10/2019 | | | | | | | |
|  | | | | | | | | |
| h. End | 1/7/2022 | | | | | | | |
|  | | | | | | | | |
| 1. Justification | | | | | | | | |
| Mobile phones and other ICT services are increasingly used to provide information and advice to farmers to facilitate learning. Yet, support for targeting and scaling agricultural technologies through ICT tools is scarce. ICT-based targeting and scaling approaches should not be considered a silver bullet. However, they can increase the reach and reduce the costs of technology dissemination compared to traditional village extension services.  Sophisticated models of technology integration in farming activities exist, but they are often very data-intensive and do not extend beyond the farm level. Muthoni *et al.* (2017[[53]](#footnote-54)) utilized spatially gridded biophysical and socio-economic layers to generate what they called “sustainable recommendation domains” (SRDs) that could be useful for scaling specific technologies. The effectiveness of the suitability assessment can be further refined as long as the features of individual farms are considered and directly related to technology characteristics during the targeting phase. Innovations in coupling knowledge among site characteristics, household features, and technology attributes with the SRDs are needed to guide the spatial targeting of suitable technologies.  The FarmMATCH approach explicitly tries to fill this knowledge gap, facilitating the matching between agricultural technologies to farms and their context. It contains 1) a learning and matching algorithm that identifies the most suitable and promising technologies for different farm types and 2) a data mining and signaling algorithm that identifies hotspots of the suitability of technologies and potential adopters. The matching algorithm combines contextual, farm, and technology characteristics to create a ranking of the suitability and adoption probability of available innovations. | | | | | | | | |
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| 2. Objectives | | | | | | | | |
| 2.1 Test and improve the ‘matching’ algorithm on a large dataset | | | | | | | | |
| 2.2 Determine the ease of scarce data collection at farms | | | | | | | | |
| 2.3 Obtain feedback from farmers on the technology priority lists | | | | | | | | |
| 2.4 Develop a mechanism for feeding collected data to the database and improving algorithm learning | | | | | | | | |
| 2.5 Develop the ‘signaling’ algorithm | | | | | | | | |
|  | | | | | | | | |
| 3. Research questions | | | | | | | | |
| 3.1 What is the quality of the generated priority lists for large samples of farms in different agroecological and socio-economic conditions? | | | | | | | | |
| 3.2 Can the necessary set of scarce data be collected swiftly and reliably from farmers upon farm visit? | | | | | | | | |
| 3.3 What are farmers’ perceptions of the generated priority list of technologies suggested for implementation? | | | | | | | | |
|  | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | |
| * Data collection: GIS and ARBES databases for intervention areas in Tanzania and Malawi will be used to select 1 km2 grid cells with surveyed households. A minimal set of supplementary data on farm and household features and on-farm technologies and practices may be collected. * We select 35-50 grid cells of 1 km2 from the three regions of Tanzania (Babati, Kongwa, Kiteto) and two districts in Malawi (Dedza, Ntcheu), so 5-10 cells per region. These cells differ in biophysical conditions (soil, rainfall, etc.) and socio-economic circumstances (e.g., distance to market). Moreover, within these cells, we have at least ten households sampled within the ARBES database collected by IFPRI; if this is not the case, additional data collection is required. In total, ca. 300 farms will be included. There should also be diversity among the sampled households in the grid cell. For each household, we analyze the main, easy-to-collect farm and household features (size, objectives, livestock, crop number, % off-farm income, etc.) and relate these to the farm practices and project-proposed technologies and techniques. The matching algorithm combines the GIS-derived data on biophysical conditions and socio-economic context circumstances with the farm features to estimate the probability of using various technologies and techniques. The data set will be divided between a training set (n=200-240) and a testing set (n=60-100). | | | | | | | | |
|  | | | | | | | | |
| 5. Data (with metrics) to be collected and uploaded on Dataverse. Generally, not applicable given that a tool is piloted rather than validating a technology. However, the information below will be collected. | | | | | | | | |
| Domain | | | Indicator | | | | Metric and scale | |
| Non-domain data | | | Compiled datasets  Programmed algorithms | | | |  | |
| Human condition | | | Capacity to experiment | | | | Willingness to implement a new farm configuration after disturbance | |
| Social | | | Equity | | | | Rating of farm configurations per group and agency (leadership roles) | |
|  | | | | | | | | |
| 6. Deliverables | | | | Means of verification | | | | Delivery date |
| 6.1 Journal article submitted | | | | PDF of submitted papers | | | | 30 Jun. 2022 |
| 6.3 Datasets and algorithms | | | | Items uploaded in Dataverse | | | | 30 Jun. 2022 |
| Note: these deliverables were also in the 2019-20 workplan. Due to delays, these will be submitted in 2022. | | | | | | | | |
|  | | | | | | | | |
| 7. How will scaling be achieved? | | | | | | | | |
| The modeling results will be discussed in farmer meetings. Findings will be shared and published. | | | | | | | | |
|  | | | | | | | | |
| 8. How are activities in this protocol inked to those of others? N/A | | | | | | | | |

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| 9. Gantt chart | | | | | | | | | | | | |
| Year/month | 2021 | | | 2022 | | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep |
| Analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| Write report |  |  |  |  |  |  |  |  |  |  |  |  |
| Write article |  |  |  |  |  |  |  |  |  |  |  |  |
| Submit data |  |  |  |  |  |  |  |  |  |  |  |  |

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| Project outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations | | | | | | | | |
| Output 5.1 | | | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | | | |
| Activity 5.1.7 | | | Conduct cost-benefit and gender analysis coupled with other socioeconomic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts | | | | | |
| Sub-activity 5.1.7.5: | | | Determine the effect of the joint adoption of improved maize varieties and maize-legume rotation on maize productivity and crop incomes in Malawi | | | | | |
|  | | | | | | | | |
| Research team | | | | | | | | |
| *Name* | | *Institution* | | | *Role* | | | |
| Julius Manda | | IITA | | | PI, data cleaning, analysis, and draft manuscript | | | |
| Regis Chikowo,  Sieglinde Snapp | | MSU | | | Provide data on the Plot and household panel survey conducted under the Africa RISING project | | | |
|  | | | | | | | | |
| Student(s) | | NIL | | | | | | |
|  | |  | | | | | | |
| Locations: | | Dedza, Mangochi and Ntcheu districts | | | | | | |
|  | |  | | | | | | |
| Start date | | October 2019 | | | | | | |
|  | |  | | | | | | |
| End date | | September 2022 | | | | | | |
|  | | | | | | | | |
| 1. Justification: Note *that is activity is a continuation from the 2019/2020 season* | | | | | | | | |
| Agriculture is the mainstay of most developing countries, with the productivity of land being central to the global goals of poverty reduction and economic development. In Malawi, the Africa RISING project has been testing and promoting sustainable intensification practices (SIPS) in the quest to improve soil fertility, maize and legume productivity among others. However, estimating the returns from SIPs is dependent on the accurate measurement of production and plot size. In most cases, smallholder self-reported plot size and production are usually plagued with measurement errors which may result in the over or underestimation of crop yields and incomes. The measurement error may be systematic and can be correlated with the adoption of SIPs (also correlated with the plot size) which may result in biased estimates on the returns. Measurement errors have also been established as one of the causes of the land productivity and plot size inverse relationship (i.e., smaller farms produce more per unit area than larger farms), commonly observed in developing countries. In this study, the SIP is the combined application of two technologies: the growing of improved maize varieties and together with their growing in maize-legume rotations. Recent studies have shown that measuring plots using Global Positioning Systems (GPS) and crop cuts for production, can overcome some of these problems. Details are given in the appended protocol. | | | | | | | | |
|  | | | | | | | | |
| 2. Objectives | | | | | | | | |
| 2.1. Estimate the yield and income returns from adopting the combination of improved maize varieties and maize-legume rotation | | | | | | | | |
| 2.2 Compare the returns from adopting the combination of improved maize varieties and maize-legume rotation using self-reported production and cultivated plots with GPS measured plots and crop cuts | | | | | | | | |
| 2.3. Examine whether the land productivity and plot size inverse relationship still hold with GPS measured plots and crop cuts | | | | | | | | |
|  | | | | | | | | |
| 3. Research questions | | | | | | | | |
| 3.1 What is the impact of the combination of improved maize varieties and maize-legume rotation on maize yields and income? | | | | | | | | |
| 3.2 Is there a difference in returns from adopting the combination of improved maize varieties and maize-legume rotation using self-reported production and cultivated plots with GPS measured plots and crop cuts? | | | | | | | | |
| 3.3 Does the land productivity and plot size inverse relationship still hold with GPS measured plots and crop cuts? | | | | | | | | |
|  | | | | | | | | |
| 4. Data collection and analysis | | | | | | | | |
| The data for the analysis will come from the panel data surveys conducted by Africa RISING from 2015-2018 in Malawi in Dedza, Mangochi and Ntcheu districts involving over 300 households and 1000 plots[[54]](#footnote-55). The Multinomial Endogenous Switching Regression (MESR) will be used to jointly estimate the impact of improved maize and maize-legume rotations adoption on maize productivity and net returns. The productivity and income returns will be compared to that of non-adopters. We use this econometric model because it accounts for the interdependency of the SIPs as well as for the observed and unobserved heterogeneity. Without accounting for these, biased estimates would be obtained. To estimate the effect of plot size on maize productivity, we take advantage of the panel data and estimate a fixed-effects regression model. Details are given in the appended protocol. | | | | | | | | |
|  | | | | | | | | |
| 5. Data (with metrics) to be obtained from DataVerse | | | | | | | | |
| Domain & Indicator | Field/plot level metrics | | | Farm level metrics | | Household level metrics | Community/landscape metrics | Measurement method |
| Productivity |  | | |  | |  |  |  |
| Crop productivity | Maize and legume producvtivity (kg/ha) | | |  | |  |  | Plot and household panel survey |
| Input use efficiency | Product per input | | |  | |  |  | Plot and household panel survey |
| Economic |  | | |  | |  |  |  |
| Profitability | Gross margin ($/ha) | | | Net income (total net income for all farm activities) | |  |  | Plot and household panel survey |
| Labor requirements | Labor hours /ha | | |  | |  |  | Plot and household panel survey |
| Returns to land, labor, and inputs | Returns (monetary value of output/input used) | | | Returns (monetary value of output/input used) | | Returns (monetary value of output/input used) |  | Plot and household panel survey |
| Environmental |  | | |  | |  |  |  |
| Pesticide use | Active ingredient applied per ha | | | Active ingredient applied per ha | |  |  | Plot and household panel survey |
| Soil biology | Total carbon (% or Mg/ha) | | |  | |  |  | Plot and household panel survey |
| Human |  | | |  | |  |  |  |
| Food security | Food production (Calories/ha/year) | | | Food production (Calories/ha/year) | | Food availability  Food accessibility |  | Plot and household panel survey |
| Social |  | | |  | |  |  |  |
| Collective action |  | | |  | | Participation in a collective action group |  | Plot and household panel survey |

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| 6. Deliverables | Means of verification | Delivery date |
| The yield and income effects of the joint adoption improved maize and maize-legume rotations identified. | Notification from a journal | Feb. 2022 |

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| --- | --- | --- | --- | --- | --- | --- |
| 7. How will scaling be achieved? NA | | | | | | |
|  | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | |
| This sub-activity is linked to sub-activity: 1.1.1.2: Investigations on the medium to long term impacts of SI technologies (improved soil fertility management, improved germplasm, crop combinations, nutrient and water management) on crop productivity on multi-locational fields sites and baby trials (PIs: Regis Chikowo; Sieg Snapp). | | | | | | |
|  | | | | | | |
| 9. Timeline of activities | | | | | | |
|  | 2021 | | | | 2022 | |
| Activities | Sep | Oct | Nov | Dec | Jan | Feb |
| Data analysis |  |  |  |  |  |  |
| Draft manuscript write-up |  |  |  |  |  |  |

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| --- | --- |
| Project outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations | |
| a. Output 5.1: | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies |
| b. Activity 5.1.7: | Conduct cost-benefit and gender analysis coupled with other socioeconomic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts |
| c. Sub-activity 5.1.7.6 | Determine the impact of the Africa RISING research on household welfare and return on investment |

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| --- | --- | --- |
| d. Research team | | |
| *Name* | *Institution* | *Role* |
| Julius Manda | IITA | PI, Agricultural economist, research design, data analysis, and writing |
| Bekele Kotu | IITA | PI, Agricultural economist, research design, data analysis, and writing |
| Carlo Azzarri | IFPRI | Agricultural economist, research design, paper revision |
| Consultants | * University Ahmadu Bello University, Nigeria * University for Development Studies, Ghana; and * MwAPATA institute, Malawi | Agricultural economists/consultants, data processing and analysis |
| Regis Chikowo | MSU | Agronomist, expert consultation on technology selection and data, Malawi |
| Sieglinde Snapp | MSU | Agronomist, expert consultation on technology selection and data, Malawi |
| Job Kihara | CIAT | Agronomist, expert consultation on technology selection and data, Tanzania |
| Elirehema Swai | TARI | Agronomist, expert consultation on technology selection and data, Tanzania |
| Birhanu Zemadim | ICRISAT | NRM scientist, expert consultation on technology selection and data, Mali |
| Felix Badolo | ICRISAT | Agricultural economist, research design, data analysis, and writing |
| Abdul Rahman Nurudeen | IITA | Agronomist, expert consultation on technology selection and data, Ghana |
| Fred Kizito | IITA | Expert consultation on technology selection, Ghana |
| Mateete Bekunda | IITA | Expert consultation on technology selection, Malawi, and Tanzania |
|  | | |
| e. Location(s) | Malawi, Tanzania, Ghana, and Mali | |
|  | | |
| f. Start | November 2020 | |
|  | | |
| g. End | September 2022 | |
|  | | |
| 1 Justification | | |
| Agricultural productivity growth has long been recognized as one of the most important and effective pathways through which agricultural research and technologies can increase rural incomes and food security and reduce poverty. To this end, the Africa RISING ESA project has been testing, validating, and promoting improved sustainable intensification (SI) technologies to increase agricultural productivity sustainably, food and nutrition security, and reduce poverty. The Africa RISING project has led to the development and diffusion of improved agricultural technologies representing a major scientific and policy achievement in east and southern Africa. Despite these achievements, rigorous impact evaluation has not been done to investigate the impact of these interventions on the return on investment (ROI) and household welfare. This study is vital in assessing whether changes in a particular outcome are due to the Africa RSING project intervention and not to other factors. Secondly, research requires some substantial investments. Therefore, to justify funding for research, it is imperative to show the return on investment, especially to the donors. | | |
|  | | |
| 2. Objectives | | |
| 1. To examine the ex-ante impacts of the Africa RISING investment on the ROI 2. To assess the factors that determine the adoption of Africa RISING technologies 3. To assess the ex-post impact of the adoption of Africa RISING technologies on the ROI, productivity, income, and food security | | |
|  | | |
| 3. Research questions | | |
| 1. What are the ex-ante impacts of the Africa RISING investment on the ROI? 2. What factors affect the adoption of the Africa RISING technologies? 3. What are the ex-post impacts of the adoption of Africa RISING technologies on the ROI, productivity, income, and food security? | | |
|  | | |
| 4. Data collection and analysis | | |
| Agricultural productivity growth has long been recognized as one of the most important and effective pathways through which agricultural research and technologies can increase rural incomes and food security and reduce poverty. To this end, the Africa RISING project has been testing, validating, and promoting improved technologies through sustainable intensification. The Africa RISING project has led to the development and diffusion of improved agricultural technologies representing a major scientific and policy achievement in West Africa as well as inEast and Southern Africa. Despite these achievements, rigorous impact evaluation has not been done to investigate the return to investment (ROI) and household welfare because of the impact of these interventions.  The Africa RISING project has validated SI technologies through farmer-managed on-farm trials in Ghana, Malawi, Mali, and Tanzania. The SI technologies that have been validated range from soil enhancing and water conservation technologies such as ISFM and tied ridges, respectively, and improved germplasm (improved maize and legume varieties) to improved postharvest technologies. Results based on these trials generally show that these technologies are essential in increasing the productivity and profitability of maize and legume production. However, research focusing on assessing the potential economic impacts of these technologies beyond profitability is lacking. This study will evaluate the potential (ex-ante) impacts of selected Africa RISING technologies on ROI to guide further investments in research and extension.  Similarly, baseline and follow-up surveys have been done in Ghana and Malawi by IFPRI on Africa RISING beneficiaries and non-beneficiaries. To date, no study has been conducted to estimate the impact of the adoption of these technologies on ROI and indicators of household welfare such as household income, food security, and poverty. In estimating the adoption effects on the selected outcome variables, we will follow and adapt earlier work in the vein by Asfaw et al. (2009)[[55]](#footnote-56), Kleemann et al. (2014)[[56]](#footnote-57), and Udry et al. (2006[[57]](#footnote-58)). | | |

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| 5. Data (with metrics) to be collected and uploaded on Dataverse | | | | | |
| Domain | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method | |
| Productivity | Grain yield | Output per hectare of land (t/ha) |  |  | Plot and household survey | |
| Economic | Net income |  | Household income per capita |  | Plot and household survey | |
| Environment | Application of good agronomic practices including soil conservation practice (GAP) |  | Proportion of land under maize on which GAP have been applied (%) |  | Plot and household survey | |
| Human | Food security |  | Dietary diversity score and child anthropometrics |  | Plot and household survey | |

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| 6. Deliverables | Means of verification | Delivery date |
| Impact of Africa RISING investments on ROI, productivity, food security, and poverty established | Draft manuscript | Jun. 2022 |

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| 9. Gantt chart | | | | | | | | | |
| Year/month | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| *NAFAKA ROI* | | | | | | | | | |
| Data analysis |  |  |  |  |  |  |  |  |  |
| Manuscript write-up and submission |  |  |  |  |  |  |  |  |  |
| *Ex-ante impact analysis* | | | | | | | | | |
| Data collection, cleaning, and organization |  |  |  |  |  |  |  |  |  |
| Data analysis |  |  |  |  |  |  |  |  |  |
| *Ex-post impact analysis* | | | | | | | | | |
| Data cleaning and analysis |  |  |  |  |  |  |  |  |  |
| Manuscript write-up submission |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | | | | | | | | |
| a. Output 5.1: | | | Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies | | | | | | | | |
| b. Activity: 5.1.7 | | | Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations | | | | | | | | |
| c. Sub-activity 5.1.7.7 | | | Scaling Sustainable intensification technologies: Lessons from three case studies in Malawi and Zambia | | | | | | | | |
|  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | |
| Name | | | | | Institution | | Role | | | | |
| Munyaradzi Mutenje | | | | | IWMI | | PI, Data analysis and draft manuscript on “Scaling Sustainable intensification technologies: Lessons from three cases studies in Malawi and Zambia” | | | | |
| Julius Manda | | | | | IITA | | Socioeconomics and impact assessment | | | | |
| Christian Thierfelder | | | | | CIMMYT | | Expert consultation on conservation agriculture | | | | |
| Bekunda Mateete | | | | | IITA | | Expert consultation on scaling | | | | |
|  | | | | | | | | | | | |
| e. Student(s): Nil | | | | | | | | | | | |
|  | | | | | | | | | | | |
| Location(s) | Malawi: Lemu, Matandika and Songani EPAs; Zambia: Chipata, Katete and Lundazi districts | | | | | | | | | | |
|  | | | | | | | | | | | |
| Start | | | | | 2021 | | | | | | |
|  | | | | | | | | | | | |
| End | | | | | 2022 | | | | | | |
|  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | |
| Sustainable Agricultural intensification technologies are perceived to have the potential to drive economic development and improve food and nutritional security in Southern Africa. Several studies have indicated that SAI technologies can enhance the productivity and resilience of smallholder farming systems while conserving the natural resource base (Kassie et al., 2015[[58]](#footnote-59): Manda et al., 2015[[59]](#footnote-60); Kotu et al., 2017[[60]](#footnote-61) ). Though many SAI practices have been developed and adapted to smallholder contexts in southern Africa, adoption levels have remained low to achieve meaningful impact and rural transformation (Bentley et al., 2018[[61]](#footnote-62)). The low adoption has been attributed partly to limited agricultural extension services and rural infrastructure required to push through the technologies and increase their accessibility to the smallholder farmers. Also, poor market integration has been highlighted as a major constraint to the sustainable uptake of the technologies after the project life cycle. There has always been an assumption from the scientific society that SAI technologies or practices proven to be viable or useful should scale out naturally like commercial products or services. However, most agricultural technologies do not scale out with such ease; scaling out needs to be well planned, funded, and facilitated (USAID, 2014[[62]](#footnote-63)). The scaling of SAI technologies has become the center of contemporary debate. Many donors, researchers, development practitioners, and non-governmental organizations have recognized the need to catalyze the scaling out of viable agricultural technologies among smallholders. Smallholder farmers are often faced with higher transaction costs that limit their access and ability to invest in proven SAI technologies essential for increasing their productivity and reducing poverty. Several SAI technologies have been developed over the last decades to solve smallholder farmers’ biophysical constraints, increasing productivity and incomes at farm scale. Yet impacts have not expanded across households, communities, and regions. Scaling improved SAI technologies to enable livelihood impacts across larger populations, nations, and regions is critical for the current development, given the population growth trend and a climate change impacts. There is a dearth of literature on strategies to bring agricultural technologies to scale (USAID, 2014). This suggests a knowledge gap in effective strategies to bring SAI technologies to scale for smallholder farmers. Therefore, this research aims to document lessons from a combination of scaling strategies implemented in Malawi and Zambia under the Africa RISING project for more than five years. The time scale varies across communities, the highest being 12 years of implementation.  The International Maize and Wheat Improvement Center (CIMMYT), working with its partners in southern and central Malawi and eastern Zambia, piloted three different scaling approaches. These included the mother-baby extension approach working with the public extension approach, farmer field schools and lead farmer approach working in partnership with two different non-governmental organization extensions and the third approach was market incentive approach with a quasi- non-governmental organization that was involved in processing cereal and legume crops into many food products. The main objective is to document the scaling process lessons from the three case studies | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | |
| 2.1 Draw lessons from each of the scaling approaches implemented based on farmers’ perception about the approach, the extension agent, community cohesion, and attitude towards development | | | | | | | | | | | |
| 2.2 Assess the scaling impacts based on the number of farmers aware, adopted, dis-adopted the SAI technologies (individually and in combinations), the area planted using panel data | | | | | | | | | | | |
| 2.3 Estimate the impact of using SAI technologies on the returns on investment (ROI) in Zambia and Malawi | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | |
| 1. What lessons can be drawn based on farmers’ perception about the approach, the extension agent, community cohesion, and attitude towards development?  2. What are the impacts of scaling of SAI technologies based on the number of farmers aware, adopted, and dis-adopted the SAI technologies (individually and in combinations)?  3. What are the impacts of SAI technologies on ROI in Zambia? | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 4. Experiment design, implementation, and data analysis | | | | | | | | | | | |
| The data to be used will include both qualitative and quantitative. Data specific to scaling approaches were collected in the 2018/2019 season through detailed case studies, semi-structured questionnaires with key informants, extension officers, and focus group discussions. The technologies that have been scaled up to include drought-tolerant maize and legume varieties, Conservation agriculture (minimum tillage, crop associations, and residue retention), doubled-up legumes (in Malawi and Zambia), and Agroforestry (only in Zambia). Data to be used for benefit-cost analysis and estimation of the ROI will come from four rounds of plot and household data from 2012-to 2021 in 6 communities in Zambia and three rounds of plot and household survey data from 10 communities in Malawi. A combination of descriptive and robust econometric techniques such as the correlated random effects (CRE) approach will be applied to estimate ROI. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 5. Data (with indicators and metrics) to be collected and uploaded on Dataverse | | | | | | | | | | | |
| Domain & *Indicator* | | Field/plot level metrics | | Farm-level metrics | | Household-level metrics | | | Community /landscape metrics | | Measurement method |
| Productivity | | | | | | | | | | | |
| *Crop productivity* | | Yield (kg/ha/ | | Yield (kg/ha) | |  | | |  | | Plot and household survey |
| Economics | | | | | | | | | | | |
| *Profitability* | | Net income/ha | | Net income/capita | | Net income/capita | | |  | | Plot and household survey |
| Human | | | | | | | | | | | |
| *Nutrition* | |  | |  | | * Household dietary diversity score (HDDS) | | |  | | Plot and household survey |
| *Food security* | |  | |  | | * Months of food insecurity | | |  | | Plot and household survey |
| Social | | | | | | | | | | | |
| *Gender equity* | |  | |  | | * Nutrition by gender * Food security by gender | | |  | | Plot and household survey and focus group discussions |
|  | | | | | | | | | | | |
| 6. Deliverables | | | | | | | | Means of verification | | Delivery date | |
| A draft manuscript on the scaling of sustainable intensification technologies: Lessons from three case studies | | | | | | | | Notification from a journal | | Apr. 2022 | |
| A policy brief on the key findings and recommendations from the scaling approaches | | | | | | | | Policy brief uploaded on CGSpace | | May 2022 | |
| A policy brief on the cost-benefit analysis of SAI technologies in Zambia and Malawi | | | | | | | | Policy brief uploaded on CGSpace | | Jul. 2022 | |
| Collected research data | | | | | | | | Data uploaded on Dataverse | | Aug. 2022 | |
|  | | | | | | | | | | | |
| 7. How will scaling be achieved? NA | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | | | | | | |
| This sub-activity is linked to ongoing sub-activity 5.1.1.4 in Malawi (Case studies: Application of SI technologies use among farmers interacting with Africa RISING at different intensities). | | | | | | | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 9. Gantt chart | | | | | | | | | | |
| Year/month | 2021 | 2022 | | | | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Data processing and analysis |  |  |  |  |  |  |  |  |  |  |
| Preparation of scientific article |  |  |  |  |  |  |  |  |  |  |
| Preparation and submission of a policy brief |  |  |  |  |  |  |  |  |  |  |
| Preparation and submission of a policy brief on benefit-cost analysis |  |  |  |  |  |  |  |  |  |  |
| Data upload |  |  |  |  |  |  |  |  |  |  |
| FtF indicators |  |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| Output 5.2 | Strategic partnerships with public and private, initiatives for the diffusion, and adoption of research products | | | |
| Activity 5.2.1 | Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways | | | |
| Sub-Activity 5.2.1.1 | Engage able and willing partners to develop a strategy and implementation framework for scaling-up intensification research technologies in semi-arid ecologies of central Tanzania | | | |
|  |  | | | |
| Systems research team: | | | | |
| Name | Institution | Role | | |
| James Mwololo | ICRISAT (PI) | Lead engagement activities with partners as well coordinate the assembly of data. | | |
| Patrick Okori | ICRISAT (COPI) | Co-Investigator who will support scaling out work | | |
| Daniel Mgalla | IITA | M&E support | | |
| Extension officers | DAICO-, Kiteto, Kongwa, | Backstop the AR and private sector as appropriate | | |
| DASPA | Farmer groups in Kongwa and Kiteto | Implement the community bank programming for seed production and access. The leadership will also coordinate with ICRISAT the lead agency for this activity | | |
|  | | | | |
| Student(s): NIL | | | | |
|  |  | | | |
| Location(s): District, Village | Kongwa District, Villages-Chitego, Mlali, Laikala and Moleti; Kiteto District- Villages-Njoro or Kiperesa and Iringa District, Village-Igula | | | |
|  |  | | | |
| Start date | November 2018 | | | |
|  |  | | | |
| End date | July 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| In the 2018-2019 cropping season, results from the sub-activity 5.2.1.1 we studied the role of power relationships among the “farming system” stakeholders to inform the scaling-out strategy for the emerging technologies. Key findings that have informed the 2019-2020; and 2021-2022 activities were that:   1. Culture influences gender and land ownership, affecting access to knowledge and technologies by farming populations. Key actors providing knowledge in Kongwa and Kiteto are mostly public institutions, i.e., extension, researchers, and civil society agencies operating at the community level. The private sector plays a subdued role, with agro-dealers and aggregators being key. The power relationships among these key actors generally promote inclusion rather than competition and exclusion. 2. The groundnut value chain studies show that farmers are dependent on public institutions and NGOs such as TARI and ICRISAT for improved plant material. Improved seed production depends mostly on farmer groups and civil society. 3. Therefore, improving seed systems to deliver technologies requires building the seed value chains from the supply side, starting with informal systems as a foundation for the private sector investment.   We identified the right sort of partnership needed to scale up technologies through production and availing of quality seed. As such MoUs with DASPA and KFS were developed, ratified and they have been operating: through 2021. Thus, this year (2021-2022), we plan to work with DASPA and KFS, to continue rolling out improved seed and allied technologies as guided by the MoUs to scale out groundnut, pigeonpea, sorghum and pearl millet technologies in Kongwa and Kiteto. Training support will be offered to DASPA and KFS team, and meetings with the seed Agency (ASA). | | | | |
|  | | | | |
| 2. Objectives | | | | |
| 2.1 Hold technology handover meetings with DAICO (Kongwa and Kiteto), ASA, TARI-Ilonga, TARI-Naliendele, DASPA, and KFS to inform the designing of training needs for field extension staff on community seed production | | | | |
| 2.2 Procure and deploy seed of underinvested crops: groundnut, pigeonpea, sorghum and pearl millet and allied innovations in Kongwa and Kiteto. DASPA and KFS are stakeholders that we have identified and entered into strategic partnerships with | | | | |
| 2.3 Promote the adoption of improved groundnut, pigeonpea, sorghum, and pearl millet and allied innovations in Kongwa and Kiteto to reach at least 2,000 households as beneficiaries of quality seed | | | | |
| 2.4 Develop knowledge products for wider dissemination of technologies (an extension bulletin) | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1 Does stakeholder engagement enhance the delivery of technologies and productivity in farming systems? | | | | |
| 3.2 What are the needed interventions to improve the functionality of the weak multi-stakeholder based technology generation to delivery systems? | | | | |
|  | | | | |
| 4. Experiment design, implementation and data analysis | | | | |
| Partner engagement: To implement this activity, we will leverage the existing partnership and working relationship between ICRISAT and DASPA, KFS and TARI. Meeting to support further scaling of technologies (seed production and grain marketing) with DASPA, KFS and stakeholders  Work design: The informal community seed bank model (Munthali and Okori, 2018[[63]](#footnote-64)), tested in Kongwa and Kiteto, has led to quality pigeonpea seed availability in central Tanzania and other locations in East and southern Africa and will be applied. Co-creation and designing including capacity building will be embraced, thus DASPA staff field staff, DAICO extension staff and TARI staff will be trained to transfer “the technology” to different stakeholders including farmer seed production groups. Community seed banks rely on farmer clubs for production, management and sale of seed as quality declared seed (QDS). We will leverage existing DASPA clubs to incorporate market and a community-based approach in the intervention and where appropriate, work collectively with DAICOs to expand the footprint of DASPA in our focus project sites towards execution of the MoU on technology scaling. Using this approach, we envisage expanding further the already established genuine commitment, transparency and equity to ensure delivery. Technology dissemination products such as technology labels will be developed. | | | | |
|  | | | | |
| 5. Data to be collected and uploaded on Dataverse   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | Farm level metrics | Household level metrics | Community/landscape metrics | Measurement method (details in research protocol) | | Economic | | | | | | | *Profitability* |  | Net income (Total net income for all farm activities) | Net income (Total net income for all farm activities) |  | Participatory Evaluation | | Social | | | | | | | *Social cohesion* |  | Participation in community activities | Participation in community activities | Incidence of social support to value chain and Ips | Focus group discussions | | Human condition | | | | | | | *Capacity to experiment* |  |  | Number of new practices being tested | Percentage of farmers experimenting | Focus group discussions | | | | | |
|  | | | | |
| 6 Deliverables | | | Means of verification | End date |
| * 1. Meetings (one Virtual (researchers and ASA) and 2 physical meetings (DASPA, KFS, and DAICOS) to support further scaling of technologies (seed production and grain marketing) with DASPA, KFS and stakeholders | | | Meeting reports | Jul. 2022 |
| * 1. Farmer groups mobilized and engaged for the activity with a target to reach at least 2,000 farmers; and production of 10 tons of foundation seed | | | Mobilisation reports | Jul. 2022 |
| * 1. One extension bulletin: “ A guide for informal seed production for underinvested crops” | | | Project reports/bulletin copies | Apr. 2022 |
| * 1. Community seed bank management | | | Technology label | Jul. 2022 |

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| 7. How will scaling be achieved? |
| This is a scaling out activity to be implemented via a strategic partnership involving local seed producer association (DASPA) grain trader (KFS) and research institution (ICRISAT and relevant TARI-centers), to supply the varieties and the DAICOs office to provide extension support and linkage to TOSCI the seed industry regulatory agency. |
|  |
| 8. How are the activities in this protocol linked to those of others? |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 9. Gantt chart | | | | | | | | | |
| Activity/month | 2021 | | 2022 | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| Meetings |  |  |  |  |  |  |  |  |  |
| Development of extension bulletin |  |  |  |  |  |  |  |  |  |
| Farmer mobilization and seed production |  |  |  |  |  |  |  |  |  |

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| Project Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| a. Output 5.2: | Strategic partnerships with public and private, initiatives for the diffusion, and adoption of research products | | | |
| b. Activity 5.2.2 | Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways | | | |
| c. Sub activity 5.2.2.1 | Support the Ministry of Agriculture and NGO Extension in scaling CA-systems In Eastern Zambia and Malawi and develop legacy knowledge products for conservation agriculture and related technologies to be used by farmers beyond the project lifetime | | | |
|  | | | | |
| d. Systems research team: | | | | |
| Name | Institution | Role | | |
| Christian Thierfelder | CIMMYT | PI, design of knowledge products | | |
| Julius Manda | IITA | Design of knowledge products | | |
| Mphatso Gama | Machinga ADD | Implementation | | |
| Mulundu Mwila | ZARI | Implementation | | |
| Richard Museka | TLC | Implementation | | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s): | NA | | | |
|  | | | | |
| g. Start date | October 2021 | | | |
|  | | | | |
| h. End date | September 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| We need to co-develop technologies with local partners and engage at different levels for adaptation, adoption, and sustainable uptake. We intend to share research results with diverse audiences at different levels and at different times within the target countries. This will be achieved in targeted meetings during the field days, evaluation meetings, and other broader meetings during the cropping season (provided COVID allows for travel). In addition, our partners will engage with the national information service to conduct radio programs and roadshows for wider coverage.  Finally, the project team will put together a range of knowledge products aimed at farmers in the target areas to enhance their knowledge and encourage uptake. | | | | |
|  | | | | |
| 2. Objectives | | | | |
| To enhance the scaling of conservation agriculture in rural communities of Malawi and Zambia | | | | |
|  | | | | |
| 3. Research questions: NA | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| Experiment design, implementation, and data analysis  The Ministry of Agriculture and NGO partners will be actively involved in managing and evaluating on-farm trials to get first-hand experiences and data on the technologies to be scaled. We plan to share data and knowledge with local partners in various events (see below). | | | | |
|  | | | | |
| 5. SI Domain (no specific domain will be addressed as the activity will is directed at creating an enabling environment | | | | Responsible institution |
|  | | | | |
| 6. Deliverables | | | Means of verification | Delivery date |
| 6.1 Evaluation meetings of technology interventions | | | Study tour report | Mar. 2022 |
| 6.2 Study tours with key players | | | Study tour report | Feb./Mar. 2022 |
| 6.3 Field days conducted | | | Annual reports | Sep. 2022 |
| 6.4 Roadshows and radio programs conducted | | | Annual reports | Sep. 2022 |
| 6.5. Detailed survey to monitor outreach of radio programs in target areas | | | Survey report | Sep. 2022 |
| 6.5 Two success stories published | | | Annual reports | Sep. 2022 |

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| 7. How will scaling be achieved? |
| Scaling will be achieved through the active involvement of the Ministry of Agriculture Staff in Zambia and Malawi, interested NGO and long-term partners (TLC), and involvement of district committee personnel in field and study tours, field days, demonstrations, and other community-based activities. Three types of scaling will be targeted: Scaling out (spatial scaling), scaling-up (make institutions change), and scaling deep (achieve a behavior change by farmers). As in 2020-2021, the project will conduct roadshows and foster radio programs, but we will closely monitor the reach of such activities this time. For roadshows, detailed attendance lists will be captured and recorded, whereas targeted surveys will monitor the reach of radio programs in the exposure sites. |
|  |
| 8. How are the activities in this protocol linked to those of others? |
| * This activity will be mainly bilateral but will include, at various stages, other players from MSU and IITA |

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| 9. Gantt chart | 2022 | | | | | | | | |
| Activity/month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Evaluation meetings |  |  |  |  |  |  |  |  |  |
| Field and study tours |  |  |  |  |  |  |  |  |  |
| Roadshows and radio programs |  |  |  |  |  |  |  |  |  |
| Survey on the outreach of radio programs |  |  |  |  |  |  |  |  |  |
| Knowledge products |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Delivery and uptake of SI innovations through building functional partnerships among research and development institutions enhanced | | | | | |
| a. Output 5.2 | Improved mechanisms for effective linkages and strategic partnerships with public, private, and other initiatives for the release, diffusion, and adoption of validated technologies established | | | | |
| b. Activity 5.2.2 | Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling the delivery of validated technologies | | | | |
| c. Sub-activity 5.2.2.6 | Partnership with Islands of Peace for increasing the adoption of good agricultural practices (GAP) in vegetable production and improving nutrition | | | | |
|  | | | | | |
| d. Scaling team: | | | | | |
| Name | | Institution | Role | | |
| Ludovic Joly | | Iles de Paix (IDP) | PI | | |
| Rosina Wanyama | | WorldVeg | Technical backstopping of the scaling activities by IDP | | |
| Daniel Mgalla | | IITA/IFPRI | M&E Support | | |
|  | | | | | |
| e. Students: Nil | | | | | |
|  | |  | | | |
| f. Locations: | | 9 villages in Karatu | | | |
|  | |  | | | |
| g. Start date | | October 2019 | | | |
|  | |  | | | |
| h. End date | | 30 September 2022 | | | |
|  | | | | | |
| 1. Justification | | | | | |
| Partnership with IDP will ensure scaling out of vegetable technologies to reach several farmers in Karatu District. Through scaling, other development agencies or initiatives that aim at taking technologies to scale like public and private extension services and a range of value chain actors would be interested in the technologies. The evidence base generated through this widespread scaling by IDP will help to catalyze further partnerships within the entire District that will put promising technologies and integrated interventions in the hands of millions of target rural households. WorldVeg will support IDP scaling approaches with technical backstopping and monitoring of scaling activities. | | | | | |
|  | | | | | |
| 2. Objectives | | | | | |
| To build the capacity of staff of IDP to efficiently scale out the vegetable technologies in 9 villages. | | | | | |
|  | | | | | |
| 3. Research questions NA | | | | | |
|  | | | | | |
| 4. Experiment design, implementation and data analysis | | | | | |
| Within the village: Targeted 350 direct beneficiaries of the program must support at least 3 farmers from his/her village with at least one technique or technology s/he benefited or learned from the program (350\*3= 1050 farmers). WorldVeg will support IDP to track the beneficiaries of the technologies as required by USAID FTF indicator guidelines. | | | | | |
|  | | | | | |
| Feed the Future (FTF) to be collected (Note: This being a scaling activity, collection of SIAF domains data is not applicable). | | | | | |
| |  |  | | --- | --- | |  | 2022 Target | | EG.3.2-25 Number of hectares under improved management practices or technologies with USG assistance [IM-level] | 320 | | EG.3.2-24 Number of individuals in the agriculture system who have applied improved management practices or technologies with USG assistance [IM-level], | 1,350 | | Value chain actor type: People in government |  | | EG.3.2-2 Number of individuals who have received USG-supported degree-granting non-nutrition-related food security training [IM-level] | 3 | | EG.3.2-7. Number of technologies, practices, and approaches under various phases of research, development, and uptake as a result of USG assistance [IM-level] | 4 | | | | | | |
|  | | | | | |
| 6. Deliverables: | | | | Means of verification | Delivery date |
| Provide technical backstopping to IDP to efficiently scale the technologies in 9 villages | | | | Technical report | 30 Aug. 2022 |
|  | | | | Partnership success story | 30 Aug. 2022 |
|  | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 8. Gantt chart | 2021 | | | 2022 | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| 1. Capacity building of staff of IDP to efficiently scale |  |  |  |  |  |  |  |  |  |  |  |
| 2.Drafting and submission of success story |  |  |  |  |  |  |  |  |  |  |  |
| 3.Drafting and submission of a technical report |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | | |
| a. Output 5.2 | Strategic partnerships with public and private, initiatives for the diffusion, and adoption of research products established | | | | |
| b. Activity 5.2.2 | Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways | | | | |
| c. Sub-activity 5.2.2.7 | Partnership with LEAD Foundation to take to scale soil and water management technologies in erosion-prone areas of Central Tanzania | | | | |
|  | | | | | |
| d. Research team | | | | | |
| Name | Institution | Role | | | |
| Elirehema Swai | TARI Makutupora | PI will liaise with LEAD Foundation, extension officers, and lead farmers | | | |
| Director -LEAD Foundation | LEAD Foundation | Providing a platform for engagement of champions and farmers who have installed terraces in their field | | | |
| Anthony Kimaro | ICRAF | Coordinate with the LEAD Director on multipurpose tree species for reinforcing the bunds | | | |
|  | | | | | |
| e. Students: Nil | | | | | |
|  | | | | | |
| e. Location(s): | Chamwino, Chemba, Mpwapwa, Kondoa, and Kongwa Districts in the semi-arid Dodoma Region | | | | |
|  | | | | | |
| f. Start date | September 2019 | | | | |
|  | | | | | |
| g. End date | September 2022 | | | | |
|  | | | | | |
| 1. Justification | | | | | |
| Africa RISING invested substantial resources in developing and validating best-bet technologies for addressing the problem of land degradation in semi-arid areas of Central Tanzania. These initiatives were geared to controlling soil erosion using Fanya juu/chini terrace technology, integrating Napier grass and Gliricidia multi-purpose tree on contour bunds for reinforcement. Identifying partners ready to engage and scale these technologies to other places with similar conditions is essential. In July 2019, the LEAD Foundation, a non-governmental organization based in Dodoma Region involved in environmental conservation, identified Fanya juu as their technology of interest. Africa RISING researchers were consulted, and a “Memorandum of Understanding” was signed to scale it up.  Over the last two cropping seasons, i.e., 2019-2020 and 2020-2021, the rollout of Fanya juu/chini terraces technology has gained momentum in the semi-arid regions of Central Tanzania. From August 2021, the LEAD Foundation has rolled out the Fanya juu/chini terrace technology in Singida Region, covering two districts bordering the Dodoma Region namely Manyoni and Ikungi. Thus, the LEAD foundation requested the Africa RISING Project to continue supporting them in terms of capacity building of the extension workers and lead farmers. In collaboration with M & E for Africa RISING project, during the 2021-2022 cropping season, a follow-up will be made on the number of hectares installed with Fanya juu/chine terrace technology and the number of farmers/households reached.  Extension officers and farmers have no access to English and or Swahili field manuals on key procedures employed and or to be followed when installing contours and terraces in the field despite achievements. Thus, the preparation of a Swahili training manual, which lead farmers and extension officers will use, is of paramount importance. To this end, land use experts, a land surveyor, the National Swahili Council, and the Africa RISING communication department will be consulted. | | | | | |
|  | | | | | |
| 2. Objectives | | | | | |
| 2.1 To strengthen the capacity of extension staff in participating villages and lead farmers for an efficient rollout of soil and water management technologies | | | | | |
| 2.2 To showcase the best bet methods of conserving soils during the agricultural show known Nane Nane to reach wider farming communities | | | | | |
| 2.3 To conduct farmers’ field days to showcase how Fanya juu/chini terrace technologies are effective in controlling soil erosion | | | | | |
| 2.4 To gather information on the number of farmers who have installed Fanya juu/chini terraces, and the total area subjected to Fanya juu/chini terrace | | | | | |
|  | | | | | |
| 3 Research questions | | | | | |
| 3.1 This is a scaling activity; no research questions are formulated | | | | | |
|  | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | |
| Experiment design, implementation, and data analysis  The LEAD Foundation started the rollout of Fanya juu terrace technology in four districts in the Dodoma region, namely Chamwino, Chemba, Mpwapwa, and Kongwa, during the 2019-2020 cropping season. Training of champion farmers for rollout in their respective villages was implemented. During the 2021-2022 cropping season, the following activities will be implemented:  *4.1* *Capacity building of key implementers*  Arising from the training needs assessment results, capacity building of extension staff in participating villages and lead farmers will be implemented.  *4.2* *Set up of demonstration on Fanya juu/chini terrace technology*  Installation of Fanya juu/chini terrace at demonstration plots in at least 5 villages in all 4 districts, thus giving 20 demonstrations and the Nane Nane show grounds.  *4.3 Conduct farmers’ field days*  In collaboration with LEAD Foundation, farmers’ field day will be conducted across sites to showcase how Fanya juu/chini terrace technologies effectively control soil erosion.  *4.4 Data collection*  Information will be collected on the following: (i) area installed with Fanya juu/chini terraces. (ii) Number of farmers reached during 2019/2020 cropping (iii) farmer challenges and adaptation. | | | | | |
|  | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | |
| These data relate to the FtF indicators | | | | Responsible institution | |
| Number of extension and lead farmers trained | | | | TARI Makutupora, LEAD Foundation | |
| Number of Fanya juu/chini terrace demonstrations established during 2020/2021 cropping season | | | | TARI Makutupora LEAD Foundation | |
| The number of beneficiaries that installed Fanya juu terrace in their fields during 2020/2021 quantified | | | | TARI Makutupora, IITA, ICRAF | |
| Acreages with Fanya juu terrace in target districts in erosion-prone areas of central Tanzania | | | | TARI Makutupora, IITA, ICRAF, LEAD Foundation | |
|  | | | | | |
| 6. Deliverables | | | Means of verification | | Delivery date |
| 6.1 At least twenty (40) demonstration sites installed with Fanya juu terrace established in new districts in Singida Region | | | Mid-term report submitted to Project Leader | | Mar. 2022 |
| 6.2 At least 30 hectares owned by champion farmers in new districts installed with Fanya juu terrace during 2021/2022 cropping season | | | Final technical report submitted to Project leader | | Sep. 2022 |
| 6.3 At least 20 extension officers across participating districts in Singida regions trained on the use of Fanya juu terrace technology during 2021/2022 through LEAD/Africa RISING partnership | | | Training report will be submitted to communication officers, ready for uploading on the Africa RISING website | | Jul. 2022 |
| 6.4 At least 300 farmers exposed to Fanya juu/chini terrace technology during agricultural shows in selected ward in Singida Region | | | Mid-term reports | | Sep. 2022 |
| 6.5 Swahili training material on procedures for installing terraces in the field prepared | | | Training material submitted to Project Communication Officer | | Apr. 2022 |
| 6.6 Validation of Swahili version of SWC training manual on procedures of installing terraces in the field. | | | Training manual validation report | | May. 2022 |
| 6.7 Stakeholders meeting, which will bring together land use expert, land surveyor, extensions, researchers, National Swahili Counsel, and lead farmers conducted | | | Stakeholders meeting report submitted to communication officer for uploading in website | | May 2022 |

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| 9. Gantt chart | | | | | | | | | | | |
| Activity/month | 2021 | | 2022 | | | | | | | | |
| Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Planning meeting with District Agricultural Extension Officers in new districts in Singida Region |  |  |  |  |  |  |  |  |  |  |  |
| Capacity building of extension workers and lead farmers in new districts |  |  |  |  |  |  |  |  |  |  |  |
| Establish demonstration on Fanya juu /chini terrace in old and new districts |  |  |  |  |  |  |  |  |  |  |  |
| Collect data on number of fields installed with Fanya juu terraces, numbers of farmers reached during 2021/2022 |  |  |  |  |  |  |  |  |  |  |  |
| Preparation of training manual on procedures for installing terraces in the field |  |  |  |  |  |  |  |  |  |  |  |
| Stakeholder’s meeting |  |  |  |  |  |  |  |  |  |  |  |
| Stakeholders’ validation meeting |  |  |  |  |  |  |  |  |  |  |  |
| Dataverse uploading of FtF data |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | |
| a. Output5.3 | Gender-sensitive decision support tools for farmers to assess technology-associated risk and opportunities used by partners. | | | |
| b. Activity 5.3.1 | Identify and communicate gender-sensitive decision support technologies in the context of different farm typologies | | | |
| c. Sub-activity 5.3.1.1 | Role of gender from farm-to-fork and the market of dryland cereals in Kiteto and Kongwa | | | |
|  | | | | |
| d. Research team | | | | |
| Name | Institution | Role | | |
| James Mwololo | ICRISAT | PI, conceptualize and design studies to answer the research questions, coordinate assembly of data from both research and monitoring activities /Support manuscript development | | |
| Patrick Okori | ICRISAT | CoPI, conceptualize and design studies to answer the research questions, coordinate assembly of data from both research and monitoring activities | | |
| Wanjiku Gichohi | ICRISAT | CoPI, engage with other Africa RISING local and CGIAR partners | | |
| Daniel Mgalla | IITA | Provide support in monitoring the research activities to ensure compliance with FtF monitoring system and uploading of data into the FtF data management system | | |
|  | | | | |
| e. Student(s): Nil | | | | |
|  | | | | |
| f. Location(s)  District, Village | Kongwa District, Villages-Chitego, Mlali, Laikala or Moleti; Kiteto District- Villages-Njoro or Kiperesa | | | |
|  | | | | |
| g. Start date | November 2018 | | | |
|  |  | | | |
| h. End date | July 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| The team has used community seed banks to scale out improved resilient and productive varieties of legumes and dryland cereals in central Tanzania's Kongwa and Kiteto districts between the 2016 to 2018 cropping seasons. Farmers who accessed sorghum and pigeonpea seeds used them for grain and seed production. Since many of these farmers are women, and the selected crops are generally food security crops, this provides pre-conditions for gender studies. Studies elsewhere show that as women’s control of household income improves, it positively influences their decisions on expenditures related to food, health, and care for children. In this study, in which we collected data from both beneficiaries and non-beneficiaries of the pigeonpea seed bank, empowerment was assessed by comparing both categories of beneficiaries. We hypothesize that access to improved seeds leads to empowerment.  Furthermore, we assume that since pigeonpea is a nutritious crop with commercial potential, improved access to quality seeds, invariably improves maternal and child nutrition outcomes. This could be through direct consumption or increased income accrued from grain sales. The income from grain sales could be used to purchase other nutrient-dense foods. Additionally, we hypothesize that where women receive the improved seed, they have greater agency to negotiate more time for household and care tasks and therefore have a greater impact on their own and their children’s nutrition outcomes.  In the 2018-2019 project year, our study focused on pigeonpea community seed banks as one of the avenues for technology delivery to the farming communities and how this is linked to women empowerment and the impacts on maternal and nutrition status. The preliminary findings from the study indicate that: (a) a significantly higher proportion of beneficiaries meet minimum dietary diversity-women (MDDW) compared to non-beneficiaries; (b) Similarly, a significantly higher proportion of the children from beneficiary households meet dietary diversity, and a significantly higher proportion of women were empowered, having greater control of resources in cases where women were the primary recipients of seed compared to cases when men received seed,  The study is crucial for understanding if legume and cereal community seedbanks can contribute to better nutrition and health outcomes for vulnerable populations. Social inequity and social inclusion are important for development (Anonymous, 2015[[64]](#footnote-65)). These issues are also critical for nutrition and income improvement. Over time, there is evidence that increased equal gender relationships within households and communities lead to better agriculture and development outcomes, including improved farm productivity and family nutrition (Abakerli, 2012[[65]](#footnote-66)). Such benefits profoundly impact households and communities hence the need for this study. These initial findings, notwithstanding, require further analysis and correction for confounding factors such as wealth. We would also like to conduct the project-level women empowerment in agriculture index (PRO-WEAI) analysis associated with nutrition outcomes. The final analyses and development of the manuscript must be finalized in 2021. In the 2021-2022 project year, our studies will focus on sorghum community seed banks and compare empowerment and its impact on the maternal and nutrition status of beneficiary households with the beneficiary households of pigeonpea seed community banks. This additional study aims to investigate the benefits of access to improved cereal seeds on maternal and child nutrition outcomes. It is anticipated that this may be different from results obtained for legumes, given that sorghum is largely grown for home consumption and is seldom sold for income, unlike pigeonpea, which serves both food and income sources. Additionally, the two studies will identify synergies for setting up cereal or legume community seedbanks with the goal to deliver nutrition and health outcomes, especially to vulnerable communities. | | | | |
|  | | | | |
| 2. Objectives | | | | |
| 2.1 To examine the association between women's empowerment in agriculture and nutritional status among children within the first 1,000 days in the project life cycle in Kongwa-Kiteto. These women are members of community seed banks and use productivity-enhancing innovations to increase their productivity. | | | | |
| 2.2 To examine the association between women's empowerment in agriculture and nutritional status among women of reproductive age (15-49 years) within the project life cycle in Kongwa Kiteto | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1 Does being a beneficiary of the community seedbank empower recipients and result in improved maternal and child nutrition outcomes? | | | | |
| 3.2 Does the gender of the recipient of the seed matter? Do we observe significant differences in maternal and child nutrition outcomes based on the gender of the seed recipient? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| Experiment design, implementation, and data analysis  The community seed banks provide an easy mechanism for scaling out improved crop varieties. Members of the seed bank may use part of the grain/seed for domestic consumption and/or may sell to gain income for their livelihoods. Therefore, community seed banks provide an opportunity to test the potential linkage between access, utilization of new technologies, and livelihood outcomes. This study will investigate to which extent Africa RISING technologies (seed) may have positive outcomes on gender, nutrition, and household income. The study will be executed through surveys and assessments such as focused group discussions, rapid rural appraisals, and farming system surveys to identify gender and dietary gaps among the community seed bank beneficiaries. This will inform the development of nutrition-sensitive packages that promote gender equity in central Tanzania through the community beneficiaries we work with. Different methods of sampling including random and purposive sampling, will be used. Questionnaires will be used as the data capture tool. Both qualitative and quantitative data will be captured. Appropriate statistical tools will be used in the data analysis. To address empowerment issues related to nutrition and health, the recently released FtF-USAID [project-Level Women’s Empowerment in Agriculture Index (pro-WEAI)](http://weai.ifpri.info/versions/pro-weai/) tool developed by IFPRI will be used. An expanded description of the design is given in the Research Protocols 2018-2019. | | | | |
|  | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/farm/household metrics |  |  | Community/landscape metrics | Measurement method (details in research protocol) | | Social |  |  |  |  |  | | Gender Equity | Agency: Time allocation by gender  Market participation by gender  Achievements:  Income by gender  Nutrition/Food security by gender  Health status by gender |  |  | Women Empowerment in Agriculture Index | Individual survey  Focus group discussions  Household survey | | Social cohesion | Level and reliability of social support  Participation in community activities |  |  | Participation in social groups | Focus group discussions  Household survey | | Human condition |  |  |  |  |  | | Food security | Food availability |  |  |  | Survey | | Capacity to experiment | Number of new practices being tested |  |  | % of farmers experimenting | Focus group discussions | | | | | |
|  | | | | |
| 6. Deliverables | | | Means of verification | Delivery date |
| Association between women's empowerment in agriculture and nutritional status among children and women of reproductive age | | | * Manuscript * Progress report | Jun. 2022 |

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| 7. How will scaling be achieved? |
| Through partnerships with non-governmental organizations interested in and implementing nutrition-sensitive and specific activities. As a first step, establishing a partnership with WFP that is already working in Kongwa Kiteto will be made. This will be done after obtaining results that are critical for informing scaling-out activities such as the World Food Programme |
|  |
| 8. How are the activities in this protocol linked to those of others? See below for the linkages |
| These activities are linked to the systems approach to generating evidence on the effect of productivity on nutrition. It will therefore feed into the systems agronomy, gender, and M&E, and have a comprehensive view of the linkages between agriculture and nutrition. |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 9. Gantt chart | | | | | | | |
| Year/month | 2021 | 2022 | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun |
| Manuscript drafting and publishing |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized | | | | | | | | | | | |
| a. Output 5.3 | Gender-sensitive decision support tools for farmers to assess technology-associated risk and opportunities used by partners | | | | | | | | | | |
| b. Activity 5.3.1 | Identify and communicate gender-sensitive decision support technologies in the context of different farm typologies | | | | | | | | | | |
| c. Sub-activity 5.3.1.2 | Identify and communicate gender-sensitive decision support tools in the context of different farm typologies | | | | | | | | | | |
|  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | |
| Name | Institution | | Role | | | | | | | | |
| Gundula Fischer | IITA | | Principal investigator, social sciences | | | | | | | | |
| Cathy Farnworth | Lead Consultant | | Social scientist: research design, data collection, and analysis | | | | | | | | |
| Elirehema Swai | TARI | | Biophysical integration, Tanzania | | | | | | | | |
| Regis Chikowo | MSU | | Biophysical integration, baseline data for selected households, Malawi | | | | | | | | |
| Julius Manda | IITA | | Support with baseline data for selected households, Tanzania | | | | | | | | |
|  | | | | | | | | | | | |
| e. Student(s): Nil | | | | | | | | | | | |
|  | | | | | | | | | | | |
| f. Location(s) | Dedza District, Malawi  Kongwa District, Tanzania | | | | | | | | | | |
|  |  | | | | | | | | | | |
| g. Start | 2021 | | | | | | | | | | |
|  |  | | | | | | | | | | |
| h. End | 2022 | | | | | | | | | | |
|  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | |
| In Malawi, Africa RISING interventions revolve around four themes: integrated maize-legume systems (including new bean varieties and double up legumes), livestock intensification (focusing on poultry and small ruminants), food processing and nutrition, and R4D platforms and networks. In Tanzania, Africa RISING’s research for development activities focused on improved crop varieties, appropriate agronomic practices, climate-smart land management practices, improved animal husbandry practices, and technologies for reducing pre-and post-harvest losses.  Technology testing in Malawi has been accompanied by gender evaluations based on the Sustainable Intensification Assessment Framework (SIAF), mandatory for Africa RISING researchers since 2017. However, an important question has not yet sufficiently been addressed, namely how household decision-making and technology adoption interact. Output 5.3 (Activity 5.3.1) in the logframe for Africa RISING East and Southern Africa stipulates an investigation of this question with an action research approach. The research will combine elements from household methodologies (Gender Action Learning System, GALS) with farmers' exchange visits. The technological focus will be on soil and water conservation technologies and legume-maize integration. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | |
| 2.1 To critically analyze and shift gendered decision-making towards more balance through household methodologies | | | | | | | | | | | |
| 2.2 To capture men's and women’s assessment criteria in decision-making for technologies | | | | | | | | | | | |
| 2.3 To develop/adapt and test a workshop format that allows farm household members to self-establish assessment criteria for technologies and make more gender-balanced decisions in relation to validated Africa RISING technologies. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | |
| 3.1 How are agricultural decisions being made at the household level and why (power balances/imbalances; demarcated areas of responsibility, etc.)? How can balanced decision-making be supported through household methodologies? (Research component 1) | | | | | | | | | | | |
| 3.2 What criteria do men and women farmers use in decision-making for or against technologies (more specifically, how do they assess risks and opportunities)? (Research component 2) | | | | | | | | | | | |
| 3.3 How can results from 1 and 2 be effectively combined in a workshop that allows farmers to explore technologies through a household methodology lens? | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | |
| Experiment design, implementation, and data analysis  We will sample 6 households in a community that has been exposed to the selected Africa RISING technologies and another 6 households that have not been exposed in a neighboring community. The sampling strategy will be purposive. It will be important that participation is truly voluntary and that participating households are provided with information on tools in advance. Respondents will have to be prepared that they will discuss intra-household decision-making (informed consent).  Research component 1: For a baseline of the selected households, we will use Africa RISING panel data in Malawi and data from an economic soil and water conservation survey recently conducted in Tanzania (Julius Manda). We will additionally use household methodology tools for farmers to self-establish a baseline of their households. The collected emic and etic baseline data will relate to decision-making, productivity, labor, and other aspects that are important for a sample description.  Research component 2: We will use mind mapping and clustering (current suggestion) to establish criteria farmers use in relation to technology selection and adoption. This data will form a platform for farmer learning processes.  Research component 3: Household members from exposed and non-exposed communities will be brought together through exchange visits. In workshops, they will apply household methodology tools to explore gendered questions around the selected technologies. Non-exposed farmers will visit the fields of exposed farmers to see how they have implemented the technologies. Farmers will be encouraged to develop their HH visions in relation to technology adoption. All visions are expected to be gender-responsive. Ideally, the national facilitators/partners will continue to support the households through at least two follow up visits that could also be used for the participatory data collection on developments, challenges, sustainability, etc. (and feed into the final version of the research article as well as their learning processes and practice). | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 5. Data (with indicators and metrics) to be collected and uploaded on Dataverse | | | | | | | | | | | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Domain & *Indicator* | Field/plot level metrics | | Farm level metrics | Household level metrics | Community /landscape metrics | Measurement method | | Social | | | | | | | | *Gender equity* |  |  | | Balances in household decision-making  Gender differences in assessment criteria for technologies |  | Household methodology tools (qualitative) | | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 6. Deliverables | | | Means of verification | | | | | | Delivery date | | |
| 6.1 Community meetings held | | | Community meeting reports | | | | | | Apr. 2021  Completed, reports submitted to Cap Dev IITA | | |
| 6.2 Blog contributions | | | Published on Africa RISING website | | | | | | Jun. 2022 | | |
| 6.3 Manuals on household methodology tools tested during the study | | | Final manual drafts submitted to communications for editing/layout and upload to CGSpace | | | | | | Apr. 2022 | | |
| 6.4 Scientific article on household methodology study | | | Manuscript submitted to a journal | | | | | | Jun. 2022 | | |
|  | | | | | | | | | | | |
| 7. How will scaling be achieved? | | | | | | | | | | | |
| In this activity, we will cooperate with extension officers in Malawi. In Malawi, the new tools will supplement household methodology tools (such as the gender balance tree) that are already used by extensionists. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 8. How are the activities in this protocol linked to those of others?  This activity is linked to sub-activity 1.2.2.2 Gender analysis of soil and water conservation technologies.  This activity is linked to Sub-activity 1.1.1.2: Investigations on the medium to long-term impacts of SI technologies (improved soil fertility management, improved germplasm, crop combinations, nutrient and water management) on crop productivity on multi-locational field sites. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 9. Gantt chart | | | | | | | | | | | |
| Activity/ month | | 2022 | | | | | | | | | |
| Jan | Feb | Mar | Apr | May | Jun | Jul | | Aug | Sep |
| Follow-up visits in Malawi and Tanzania | |  |  |  |  |  |  |  | |  |  |
| Data processing and analysis | |  |  |  |  |  |  |  | |  |  |
| Translation, editing, and layout of manuals | |  |  |  |  |  |  |  | |  |  |
| Revisions of journal article | |  |  |  |  |  |  |  | |  |  |
| Blog preparation for comms | |  |  |  |  |  |  |  | |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Outcome 5: Partnerships for scaling sustainable intensification research products and validated innovations operationalized | | | | | | | | | | | | | | | |
| a. Output 5.4 | Technology adoption, monitoring, evaluation, and learning framework for use by the project team and scaling partners released [led by IFPRI and used by project partners] | | | | | | | | | | | | | | |
| b. Activity 5.4.1 | Monitor and modify the progress of technology adoption process towards scaling | | | | | | | | | | | | | | |
| c. Sub-activity 5.4.1.1 | Populate the Beneficiary and Technology Tracking Tool (BTTT) with the remaining 1,000 names of beneficiaries and technologies in Zambia with information about Africa RISING technologies applied, and farmers/households engaged in validating the technologies | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | Institution | | | | | Role | | | | | | | |
| Daniel Mgalla | | | IITA | | | | | Verifying submitted data | | | | | | | |
| Researchers | | | Africa RISING partners | | | | | Provision of direct beneficiary data | | | | | | | |
| Haile Beliyou | | | IFPRI | | | | | Verifying submitted data | | | | | | | |
| Kasa Leulsegged | | | IFPRI | | | | | Verifying the submitted data | | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s): Nil | | | | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| f. Location(s) | | | Malawi, Zambia, Tanzania | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| g. Start | | | October 2021 | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| h. End | | | December 2021 | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| The collection of beneficiary information is crucial for tracking technology transfer, adoption, and farmers’ response to research activities at different levels for Phase II of the Africa RISING Project implementation in ESA. Therefore, continuous update of the Beneficiary and Technology Tracking Tool (BTTT) is critical for the diverse needs of the project and forms an important input to periodic reporting to USAID and other interested stakeholders. The BTTT tool for the ESA region has for a long time been updated with names of beneficiaries but without the technologies they applied. While updating new beneficiaries will continue this year and update of technologies is still ongoing in all ESA countries, the tool will be finalized to be updated with technologies to ensure that each farmer is mapped to the technology of his/her association during development or testing and validation of these technologies. While more updates have been done in Tanzania and Malawi, more than 1,000 names of beneficiaries that have been reported from Zambia in September 2021 are yet to be updated, and this exercise will continue up to December 2021. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 To harmonize, populate, and document the Beneficiary and Technology Tracking Tool (BTTT) for the remaining 1,000+ beneficiaries in Zambia | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions: NA | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| Data will be collected from researchers using a standard tool provided to them in June 2020 that the researchers are using to populate names of new beneficiaries and associated technologies). The data to be collected will be on households involved during the phases of technology validation, including gender specificity. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded in BTTT | | | | | Responsibility/Institution | | | | | | | | | | |
| 5.1 Direct beneficiary data | | | | | AR partners/different institutions,  Daniel Mgalla/IITA | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 6. Deliverables | | Means of verification | | | | | | | | | | Delivery date | | | |
| 6.1 Updated, harmonized, and documented BTTT version for Zambia | | Activity report submitted to Chief Scientist, progress report submitted to Chief Scientist, and updated BTTT in Africa RISING Websites | | | | | | | | | | Dec. 2021 | | | |
|  | | | | | | | | | | | | | | | |
| 7. How will scaling be achieved? NA | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 9. Gantt chart | | | | | | | | | | | | | | | |
| Activity/Month | | | | 2021 | | | | | 2022 | | | | | | |
| Oct | | Nov | Dec | | Jan | Feb | Mar | | Apr | May | Jun |
| Update, harmonize and document the new version of BTTT for Zambia | | | |  | |  |  | |  |  |  | |  |  |  |

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| Outcome 5: Partnerships for scaling sustainable intensification research products and validated innovations operationalized | | | | | | |
| a. Output 5.4. | Technology adoption, monitoring, evaluation, and learning framework for use by the project team and scaling partners released [led by IFPRI and used by project partners] | | | | | |
| b. Activity 5.4.1 | Monitor and modify the progress of the technology adoption process toward scaling | | | | | |
| c. Sub-activity 5.4.1.2 | Collaborate with development partners to track and document scaling activities and beneficiaries using scaling tools with detailed information on scaling data for Tanzania | | | | | |
|  | | | | | | |
| d. Research team | | | | | | |
| Name | | Institution | Role | | | |
| Daniel Mgalla | | IITA | Verifying submitted data and tracking progress against targets | | | |
| Researchers | | AR partners | Linking Africa RISING M&E and Data Manager with development partners | | | |
| Haile Beliyou | | IFPRI | Verifying submitted data and tracking progress against targets | | | |
| Kasa Leulsegged | | IFPRI | Verifying the submitted data and tracking progress against targets | | | |
| Development partners | | LEAD Foundation, government agencies, IOP | Proving scaling details | | | |
|  | | | | | | |
| e. Student(s): Nil | | | | | | |
|  | | | | | | |
| f. Location(s) | | Tanzania | | | | |
|  | |  | | | | |
| g. Start | | October 2021 | | | | |
|  | |  | | | | |
| h. End | | September 2022 | | | | |
|  | | | | | | |
| 1. Justification | | | | | | |
| The collection of beneficiary information is crucial for tracking technology transfer(scaling) and farmers’ response to research activities at different levels for Phase II of the Africa RISING Project implementation in ESA. Therefore, continuous update of the scaling tool is critical for the diverse needs of the project and forms an important input to periodic reporting to USAID and other interested stakeholders. Therefore, the scaling tool for the ESA region needs to be updated with scaling data from IDP in Karatu and the Lead foundation involved in the Africa RISING technology scaling activities in Singida and Monduli districts. | | | | | | |
|  | | | | | | |
| 2. Objectives | | | | | | |
| 2.1 To populate and document the scaling tool with detailed data on scaling for Tanzania | | | | | | |
| 2.2 To track the progress of 2022 scaling beneficiaries against targeted cumulative scaling beneficiaries for 2021 | | | | | | |
|  | | | | | | |
| 3. Research questions: NA | | | | | | |
|  | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | |
| Data will be collected from researchers using a standard Africa RISING scaling tool or other relevant tools as per development partners | | | | | | |
|  | | | | | | |
| 5. Data to be collected and uploaded in Scaling tool | | | | | Responsibility/Institution | |
| 5.1 All details of technologies, approaches and scaling data | | | | | Daniel Mgalla/IITA  Development partners,  Related researchers | |
|  | | | | | | |
| 6. Deliverables | | | | Means of verification | | Delivery date |
| 6.1 Complete package of the Africa RISING ESA Project  Details on the number of scaling beneficiaries, technologies scaled, responsible researchers, name of the development partner, scaling approach | | | | Activity report submitted to Chief Scientist, progress report submitted to Chief Scientist, and updated workbook in Africa RISING Websites,  FTF data uploaded into USAID DIS system | | Oct. 2021 -Sep. 2022 |
|  | | | | | | |
| 7. How will scaling be achieved? NA | | | | | | |
|  | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | |
| The activity is linked to all other sub-activities associated with technology scaling (Outcome 5) as outlined in the Africa RISING 2021-2022 workplan for researchers (Elirehema Swai, Sognibe D’Nikou, Anthony Kimaro) | | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 9. Gantt chart | | | | | | | | | | | | |
| Year/month | 2021 | | | 2022 | | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Update, harmonize and document scaling tool with all details of technologies (scaling beneficiaries numbers reached, development partners involved, scaling approaches used) for Tanzania |  |  |  |  |  |  |  |  |  |  |  |  |

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| Outcome 5: Partnerships for scaling sustainable intensification research products and validated innovations operationalized | | | | | | | | |
| a. Output 5.4. | | Technology adoption, monitoring, evaluation, and learning framework for use by the project team and scaling partners released [led by IFPRI and used by project partners] | | | | | | |
| b. Activity 5.4.1 | | Collaborate with lead researchers to monitor and modify the progress of the technology adoption process towards scaling | | | | | | |
| c. Sub-activity 5.4.1.3 | | Collect and verify report rack up data and enter the data in the USAID research rack up database | | | | | | |
|  | | | | | | | | |
| d. Research team | | | | | | | | |
| Name | Institution | | | | Role | | | |
| Daniel Mgalla | IITA | | | | Collect and verify the submitted data from researchers | | | |
| Researchers | AR partners | | | | Providing data on research rack up details | | | |
| Haile Beliyou | IFPRI | | | | Review the data submitted | | | |
| Kasa Leulsegged | IFPRI | | | | Review the data submitted | | | |
|  | | | | | | | | |
| e. Student(s): Nil | | | | | | | | |
|  | | | | | | | | |
| f. Location(s) | Malawi, Zambia, Tanzania | | | | | | | |
|  |  | | | | | | | |
| g. Start | October 2021 | | | | | | | |
|  |  | | | | | | | |
| h. End | September 2022 | | | | | | | |
|  | | | | | | | | |
| 1. Justification | | | | | | | | |
| In 2019, USAID requested their different implementing partners to collect this information and populate it in the Research Rack-Up data collection tool, which is intended to compile information on research outputs (e.g., technologies, practices, and approaches) that have been created with assistance from Feed the Future. For USAID and their research partners, this tool helps to ease the tracking of the generation and fate of research products.  The descriptive data collected here is critical in facilitating USAID’s efforts to monitor, evaluate, and communicate the impact of research investments in alignment with the Global Food Security Act’s goals of decreasing global poverty, hunger, and malnutrition.  The Research Rack-Up complements data captured in the Feed the Future Monitoring System (FTFMS), particularly EG.3.2-7 in the [Feed the Future Indicator Handbook](https://www.agrilinks.org/sites/default/files/ftf-indicator-handbook-march-2018-508.pdf) (pg. 85-92), and provides detailed data on Feed the Future research outputs. The data captured will inform:   1. progress and impact of innovations funded by USAID as well as reporting to appropriate congressional committees; 2. facilitation of uptake by curating information on the types of innovations 3. development of the evidence needed to manage and implement programs focused on generating and accelerating research impacts.   Africa RISING researchers have been working on developing, testing, and validating various technologies since 2012, and since then, more than 58 technologies have been reported in the FtF indicator sheet. In the 2019-2020 reporting season, only 16 technologies were reported and entered into the research rack-up database. In this reporting season(2021-2022), the plan is to enter all the technologies details that will be reported by researchers in FTF and later enter timely all the data in the USAID research rack-up database (12 November 2021) | | | | | | | | |
|  | | | | | | | | |
| 2. Objectives | | | | | | | | |
| 2.1 To collect, verify and enter all the research rack up data into the USAID system by 12th November 2021 | | | | | | | | |
|  | | | | | | | | |
| 3. Research questions | | | | | | | | |
| NA | | | | | | | | |
|  | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | |
| I will work with Africa RISING researchers to collect data using the research rack up data collection tool, which will later be entered in the USAID research rack up database | | | | | | | | |
|  | | | | | | | | |
| 5. Data to be collected and entered in the research rack up tool | | | | Responsibility/Institution | | | | |
| 5.1 Research rack up data details (research output title, description, output type, phases of the output in R&D, type of technology, technology recipient type and name if scaled, crop/breed type, research partners and type, country/region technology evaluated and released, Feed the Future Innovation Exchange Information (FTFIE), etc. | | | | Daniel Mgalla/ IITA,  AR researchers/partner institutions | | | | |
|  | | | | | | | | |
| 6. Deliverables | | | Means of verification | | | Delivery date | | |
| 6.2 Research rack up data (research output title, description, output type, phases of the output in R&D, type of technology, technology recipient type and name if scaled, crop/breed type, research partners and type, country/region technology evaluated, and released, Feed the Future Innovation Exchange Information (FTFIE) for all technologies submitted to USAID web-based research rack up data for 2021 | | | Activity report submitted to Chief Scientist and IFPRI and uploaded at Africa RISING website | | | November 2021 | | |
|  | | | | | | | | |
| 7. How will scaling be achieved? | | | | | | | | |
| NA | | | | | | | | |
|  | | | | | | | | |
| 8. How are the activities in this protocol linked to those of others? | | | | | | | | |
| The activity is linked to all other sub-activities associated with the Africa RISING research component (Outcome 1-4) as outlined in the Africa RISING 2021/2022 workplan for all the researchers. | | | | | | | | |
|  | | | | | | | | |
| 9. Gantt chart | | | | | | | | |
| Year/month | | | | | 2021 | | | |
| Oct | | Nov | Dec |
| Collect and verify all the research rack up data already submitted | | | | |  | |  |  |
| Enter compiled research rack up data for all technologies to USAID web-based research rack up database | | | | |  | |  |  |

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| Outcome 5: Partnerships for scaling sustainable intensification research products and validated innovations operationalized | | | | | |
| a. Output 5.4. | Technology adoption, monitoring, evaluation, and learning framework for use by the project team and scaling partners released [led by IFPRI and used by project partners] | | | | |
| b. Activity 5.4.1 | Monitor and modify the progress of the technology adoption process towards scaling | | | | |
| c. Sub-activity 5.4.1.5 | Support ESA research partners to ensure timely (and complete) submission of FTF indicators data, research rack up data, country narratives, IM performance narratives, Dataverse submissions, and compliance with the Africa RISING Data Management Plan (Dataverse data uploading and sharing) for the Fiscal Year 2022 | | | | |
|  | | | | | |
| d. Research team | | | | | |
| Name | Institution | Role | | | |
| Daniel Mgalla | IITA | 1. Support researchers on quality submission of data for Dataverse 2. Support researchers on proper submission of FtF data to address gaps in achievement and target data mismatch for age-gender dis-aggregation, narratives for 10% difference, IM performance, and country narratives 3. Review submitted FtF data, datasets, and metadata before submission into Dataverse | | | |
| Haile Beliyou | IFPRI | Reviewing final submitted FtF data and datasets before submission into DIS and Dataverse | | | |
| Kasa Leulsegged | IFPRI | Reviewing final submitted FtF data and datasets before submission into DIS and Dataverse | | | |
| AR Researchers | AR partners | Providing data sets, FtF indicators, and metadata for review | | | |
|  | | | | | |
| e. Student(s) | | | | | |
|  | | | | | |
| f. Location(s) | Malawi, Zambia, Tanzania | | | | |
|  | | | | | |
| g. Start | September 2021 | | | | |
|  | | | | | |
| h. End | September 2022 | | | | |
|  | | | | | |
| 1. Justification | | | | | |
| Working with researchers is important to ensure timely and complete submission of FtF indicators data in each Fiscal Year. To guide them to review their target data, compile FtF data on actual achievements on yearly bases, ensure data are consistent with an adequate level of disaggregation, and write narrative information every time the difference between actual and target is more/less than 10%. During the data submission in the last reporting period, nearly all researchers had noted gaps in their submitted FTF data and IM performance narratives. Given this, I will support researchers in Malawi, Zambia, and Tanzania to ensure data quality and compliance with the Africa RSING data management plan is adhered to and observed when filling the FtF indicator forms along with their IM performance narratives. | | | | | |
|  | | | | | |
| 2. Objectives | | | | | |
| 2.1 To ensure timely (and complete) submission and uploading of FtF indicators data and IM performance narratives in the USAID DIS systems for the Fiscal Year 2022.  2.2 To ensure timely submission, uploading, and compliance of Africa RISING Data Management Plan (Dataverse data uploading and sharing) for the fiscal year 2022. | | | | | |
|  | | | | | |
| 3. Research questions: NA | | | | | |
|  | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | |
| Africa RISING researchers will submit to M&E & data manager all the FtF, Datasets and metadata, IM performance narratives for reviewing the key data quality dimensions as per data management plan and uploading to the corresponding systems (DIS and Dataverse). | | | | | |
|  | | | | | |
| 5. Data to be used, collected, and uploaded | | | | Responsibility/Institution | |
| 5.1 Datasets and metadata | | | | AR researchers/partner institutions | |
| 5.2 FTF data | | | | AR researchers/partner institutions | |
| 5.3 Reviewed data sets, metadata, IM performance narratives, and country narratives | | | | Daniel Mgalla/IITA | |
|  | | | | | |
| 6. Deliverables | | | Means of verification | | Delivery date |
| 6.1 Workbook with data summary on 2021 achievements on the five FtF indicators and for each ESA country, disaggregated by individual research theme/group who submitted indicator target and additional data as necessary, list of IM performance and country narratives | | | Activity report, progress report, and FtF data, narratives uploaded in DIS system | | Dec. 2021 |
| 6.2 Workbook with data summary on 2021/2022 achievements on Dataverse uploading for the surveys that will extend to 2022 and those pending individual items submission for backlogs pending from 2017 | | | Activity report, progress report, and Dataverse submissions review and uploading to the Dataverse system | | Sep. 2022 |
|  | | | | | |
| 7. How will scaling be achieved? NA | | | | | |
|  | | | | | |
| 1. How are the activities in this protocol linked to those of others? | | | | | |
| The activity is linked to all other sub-activities associated with Africa RISING research component (outcome 1-4) as outlined in the Africa RISING 2021-2022 workplan for all the researchers. | | | | | |
|  | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 9. Gantt chart | | | | | | | | | | | | |
| Activity/Month | 2021 | | | 2022 | | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Review and support researchers on quality submission of data for Dataverse, FtF indicators, IM performance narratives for Tanzania |  |  |  |  |  |  |  |  |  |  |  |  |
| Review and support researchers on quality submission of data for Dataverse, FtF indicators, IM performance narratives for Zambia |  |  |  |  |  |  |  |  |  |  |  |  |
| Review and support researchers on quality submission of data for Dataverse, FtF indicators, IM performance narratives for Malawi |  |  |  |  |  |  |  |  |  |  |  |  |
| Support researchers in the ESA region to ensure quality submission and compliance to Africa RSING data management for timely submission of the Dataverse data for the surveys that will extend to 2022 |  |  |  |  |  |  |  |  |  |  |  |  |

# Consolidated ESA 2021-2022 project budget

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sub-activity/ institute** | **Leader** | **CIMMYT** | **MSU** | **ICRAF** | **CIAT** | **IITA** | **WorldVeg** | **WUR** | **TARI-Makutupora** | **ICRISAT** | **IWMI** | **Total** |
| 1.1.1.2 Investigations on the medium to long-term impacts of SI technologies (improved soil fertility management, improved germplasm, crop combinations, nutrient and water management) on crop productivity on multi-locational field sites and baby trials | MSU |  | 77,112 |  |  |  |  |  |  |  |  | 77,112 |
| 1.1.1.5: Determining the productivity and resilience benefits of Gliricidia-based cropping systems | ICRAF |  |  | 48,722 |  | 800 |  |  |  |  |  | 49,2221 |
| 1.1.1.6 Assess the uptake and adaptation of new crop configurations- (Mbili Mbili technology)- and understand the influencing factors | CIAT |  |  |  | 66,909 |  |  |  |  |  |  | 66,909 |
| 1.1.1.8 Exploring the sustainable intensification pathways of farming system case studies in Tanzania and assessing the impact of Africa RISING technologies on resilience | IITA |  |  |  |  | 12,000 |  |  |  |  |  | 12,000 |
| 1.1.2.1 Assessment of the benefits of management technologies on performance of improved vegetable varieties (season 2) | WorldVeg |  |  |  |  |  | 39,0310 |  |  |  |  | 39,031 |
| 1.3.1.1 Farmer/Extension messaging to scale-out Africa RISING technologies (forage production and use, crop residue processing and use, and feed rations) using MWANGA and engagement of public and private sector partners for ownership of MWANGA | CIAT |  |  |  | 61,929 | 20,000 |  |  |  |  |  | 81,929 |
| 1.3.1.2 Refine regionally relevant extrapolation domain maps for validated conservation agriculture (CA) practices | IITA-Muthoni |  |  |  |  | 21,000 |  |  |  |  |  | 21,000 |
| 1.3.1.3 Produce regionally relevant extrapolation domain maps for validated soil and water conservation practices | IITA-Muthoni |  |  |  |  | 2,000 |  |  |  |  |  | 2,000 |
| **TOTAL OUTCOME 1** |  | **0** | **77,112** | **48,722** | **128,838** | **55,800** | **39,031** | **0** |  | **0** |  | **349,503** |
| 2.1.1.1 Assessing the buffer and adapative capacity to harness the resilience of different farm types | WUR |  |  |  |  |  |  | 0 |  |  |  | 0 |
| 2.2.1.2 Investigations on nutrient and water management for climate resilience along a climate gradient in southern Malawi | MSU |  | 39,112 |  |  |  |  |  |  |  |  | 39,112 |
| 2.2.1.6 Validation of residual tied ridging as a labor-saving technology in semi-arid Areas of Central Tanzania | TARI-Makutupora |  |  |  |  |  |  |  | 17,820 |  |  | 17,820 |
| **TOTAL OUTCOME 2** | **0** | **0** | **39,112** | **0** | **0** | **0** | **0** | **0** | **17,820** | **0** |  | **56,932** |
| 3.1.1.1 Assess the impact of nutritional messaging on farmers' nutritional knowledge, attitude and practices and household nutrition status, in partnership with Islands of Peace | WorldVeg |  |  |  |  |  | 28,531 |  |  |  |  | 28,531 |
| 3.1.1.2 Evaluate the influence of farmer storage structures and environment on physical and economic losses abatement by hermentic storage devices | IITA |  |  |  |  | 9,100 |  |  |  |  |  | 9,100 |
| 3.2.1.1 Elucidate pathways to sustainable adoption of nutrient diets and aflatoxin mitigation practices in rural communities of Central Tanzania | ICRISAT |  |  |  |  |  |  |  |  | 20,476 |  | 20,476 |
| **TOTAL OUTCOME 3** |  | **0** | **0** | **0** | **0** | **9,100** | **28,531** | **0** | **0** | **20,476** | **0** | **58,107** |
| Sub-activity 4.1.1.2 Enhancement of the groundnut seed value chain in central Tanzania: Imperatives for improving functionality | ICRISAT |  |  |  |  | 1,000 |  |  |  | 15,976 |  | 16,976 |
| 4.1.1.3 Assess how ISFM practices affect farmers’ livelihoods as a result of Africa RISING activities in Babati | CIAT |  |  |  | 69,680 |  |  |  |  |  |  | 69,689 |
| 4.1.1.4 Assess how the implementation of ISFM practices affect farmers’ livelihoods as a result of Africa RISING activities in Kongwa | TARI-Makutupora |  |  |  | 21,189 |  |  |  | 10,010 |  |  | 31,199 |
| 4.1.1.5 Value chain analysis of nutrient-dense common bean varieties in Malawi | MSU |  | 33,112 |  |  | 3,000 |  |  |  |  |  | 36,112 |
| 4.1.5.1 Impact of smallholder commercialization on household income and nutrition in Ghana and Malawi | IITA |  |  |  |  | 8,190 |  |  |  |  |  | 8,190 |
| **TOTAL OUTCOME 4** |  | **0** | **33,112** | **0** | **90,878** | **12,190** | **0** | **0** | **10,010** | **15,976** |  | **162,166** |
| 5.1.1.1 Continued experimentation in 6 target communities of Eastern Zambia and 9 communities in in Central and Southern Malawi with already established clustered CA trials | CIMMYT | 186,817 |  |  |  |  |  |  |  |  |  | 168,120 |
| 5.1.1.2 Explore the productivity domains of selected legumes and cereals to elucidate their best fitting cropping system at community/landscape level and their dissemination | ICRISAT |  |  |  |  |  |  |  |  | 14,567 |  | 14,567 |
| 5.1.1.4 Case-studies: Application of SI technologies use among farmers interacting with Africa RISING at different intensities | MSU |  | 83,500 |  |  | 9,000 |  | 14,000 |  |  |  | 106,500 |
| 5.1.1.5 Panel survey, soils processing and meta-analysis studies for maize-grain legumes sequences and implications for sustainability | MSU |  | 37,112 |  |  | 2,000 |  |  |  |  |  | 39,112 |
| 5.1.2.1 Apply APSIM crop simulation model to assess changes in resource use efficiencies, productivity and profitability of the different cropping systems in Kongwa, Kiteto and Iringa in Tanzania | ICRISAT |  |  |  |  |  |  |  |  | 11,476 |  | 11,476 |
| 5.1.2.2 Evaluate the potential contributions of integrated soil-fertility management around the five SIAF domains with emphasis on Africa RISING interventions in Tanzania | CIAT |  |  |  | 65,435 |  |  |  |  |  |  | 65,435 |
| 5.1.2.3 Synthesizing information, knowledge, and tools Africa RISING - ESA has generated over its lifetime (10 years) guided by the Sustainable Intensification Assessment Framework (SIAF) which has been central to informing the benefits and trade-offs during the implementation of different activities | MSU | 5,500 | 127,686 |  | 5,500 | 8,000 | 6,050 |  |  | 13,750 |  | 166,486 |
| 5.1.6.1 Small-scale piloting of FarmMATCH – a framework for typology-based targeting and scaling of agricultural innovations. (Matching Agricultural Technologies to Farms and their Context) | WUR |  |  |  |  |  |  | 0 |  |  |  | 0 |
| 5.1.7.5 Determine the effect of joint adoption of improved varities and maize-legume rotation on mzie productivity and crop incomes in Malawi | IITA |  |  |  |  | 8.190 |  |  |  |  |  | 8,190 |
| 5.1.7.6 Determine the impact of Africa RISING research on household welfare and return on investment | IITA |  |  |  |  | 13,388 |  |  |  |  |  | 13,388 |
| 5.1.7.7 Scaling sustainable intensification technologies: lessons from three case studies in Malawi and Zambia | IWMI |  |  |  |  |  |  |  |  |  | 21,000 | 21,000 |
| 5.2.1.1 Engage able and willing partners to develop a strategy and implementation framework for scaling up intensification research technologies in semi-arid ecologies of central Tanzania | ICRISAT |  |  |  |  |  |  |  |  | 24,376 |  | 24,376 |
| 5.2.2.1 Support the Ministry of Agriculture and NGO extension in scaling CA systems in Eastern Zambia and Malawi | CIMMYT | 38,917 |  |  |  |  |  |  |  |  |  | 38,917 |
| 5.2.2.6 Partnership with Iles de Paix (IDP) for increasing the adoption of improved vegetable varieties and good agricultural practices (GAP) in vegetable production in 9 new villages in Karatu | WorldVeg |  |  |  |  |  | 20,331 |  |  |  |  | 20,331 |
| 5.2.2.7 Partnership with LEAD Foundation to take to scale soil and water management technologies in erosion-prone areas of Central Tanzania | TARI-Makutupora |  |  |  |  | 4,000. |  |  | 27,500 |  |  | 31,500 |
| 5.3.1.1 Role of gender from farm-to-fork and the market of grain legumes and dryland cereals in Kiteto and Kongwa (data already collected and partly presented; more in-depth analysis needed) | ICRISAT |  |  |  |  |  |  |  |  | 8,476 |  | 8,476 |
| 5.3.1.2 Identify and communicate gender-sensitive decision support tools in the context of different farm typologies | IITA |  |  |  |  | 90,000 |  |  |  |  |  | 90,000 |
| 5.4.1.1 Populating the Beneficiary and Technology Tracking Tool (BTTT) and scaling tool for Tanzania, Malawi, and Zambia with information about AR technologies applied, and farmers/households engaged in validating the technologies, scaling beneficiaries | IITA |  |  |  |  | 1,000 |  |  |  |  |  | 1,000 |
| 5.4.1.2 Provide additional training and work with ESA research partners to ensure timely (and complete) submission of FTF indicators data, research rack up data, country narratives, IM performance narratives for Fiscal Year 2021, compliance with the AR Data Management Plan (Dataverse data uploading and sharing) | IITA |  |  |  |  | 1,000 |  |  |  |  |  | 1,000 |
| 5.4.1.3 Design simple research rack up database and populate it with research rack up data for Tanzania, Malawi, and Zambia | IITA |  |  |  |  | 1,000 |  |  |  |  |  | 1,000 |
| 5.4.1.5 Provide additional capacity building and work with ESA research partners to ensure timely (and complete) submission of FTF indicators data, research rack up data, country narratives, IM performance narratives for Fiscal Year 2021, compliance with the AR Data Management Plan (Dataverse data uploading and sharing) | IITA |  |  |  |  | 1,000 |  |  |  |  |  | 1,000 |
| 5.4.1.6 Work with researchers to undertake various targeted studies on technology adoption, technology scaling in various phases to different entities | IITA |  |  |  |  | 1,000 |  |  |  |  |  | 1,000 |
| **TOTAL Outcome 5** |  | **231,234** | **248,298** | **0** | **70,935** | **142,587** | **26,3810** | **14,000** | **27,500** | **72,653** | **21,000** | **816,028** |
| **TOTAL workplan** |  | **231,234** | **397,634** | **48,722** | **290,651** | **218,303** | **93,944** | **14,000** | **55,330** | **109,105** | **21,000** | **1,479,922** |

**Annex**

**Sub-activity 5.1.2.3 Synthesis sub-activities workplan**

**Sub-activity leader: Sieg Snapp**

The general approach will be to identify and document information, knowledge, and tools Africa RISING - ESA has generated over its lifetime (10 years). During the latter half of implementing Africa RISING, the Sustainable Intensification Assessment Framework (SIAF) has been central to informing the benefits and trade-offs during the implementation of different activities. Thus, as much as possible, the arguments for this sub-activity will be guided by SIAF’s five SI domains. This sub-activity will be informed by Africa RISING literature, data, and broadened with literature beyond that of Africa RISING. As part of the development of this sub-activity, we have identified some missing information, knowledge, and tools that Africa RISING ESA did not generate. We propose generating that information in the short-term, through research activities labeled Part 2.

We have created 5 teams (A, B, C, D, E) that focus on different SIAF aspects. Two of the 5 teams will collect additional data.

**A: SOC**

Part 1. Synthesis: Strategies to sustain gains in soil carbon for adaptation and mitigation of climate change

Team: R. Chikowo (MSU), C. Thierfelder (CIMMYT), L. Claessens (IITA) Coach Cheryl Palm (University of Florida)

Part 2**:** Research activity: Quantifying the SOC gains -soil carbon sequestration in long-term on-farm trials in central Malawi

Team: R. Chikowo, C. (MSU), Thierfelder (CIMMYT), Sieg Snapp (MSU/CIMMYT)

**B: Farmers’ access to seeds and technologies: Innovations in enabling farmers to take up practices and access quality seeds**

Team: J. Manda (IITA), S. Ndanikou (WorldVeg), J. Mwololo (ICRISAT), Rosina Wanyama (WorldVeg), P. Okori (ICRISAT). **Coach Sieg Snapp (MSU)/Phil Grabowski (Taylor University)**

**C: Linking human, plant, and soil nutrition: Field crop and vegetable system technologies that enhance the nutrition of humans, plants, animals, and soils.**

Team: A. Mwangwela (LUANAR), J. Kihara (Alliance Bioversity CIAT), R. Chikowo (MSU), **Coach Phil Grabowski (Taylor University)**

**D: Enhancing biodiversity, agroforestry, shrubby legume, and crop diversity**

Team: R. Chikowo (MSU), C. Thierfelder (CIMMYT), F. Muthoni (IITA), and J. Kihara (Alliance Bioversity CIAT**). Coach Alexia Witcombe (MSU)**

Part 2**:** Research activity: Investigations of soil biodiversity in long-term on-farm trials in central Malawi

Team: Elizabeth Ngadze (University of Zimbabwe), Alexia Witcombe (MSU), R. Chikowo (MSU), Sieg Snapp (MSU)

**E: SIAF expansion to be more participatory and responsive to social sciences, especially gender awareness**

Team: **Coach Gundula Fisher** (IITA), and all Africa RISING scientists

**A: SOC**

Part 1. Synthesis: **Strategies to sustain gains in soil carbon** for adaptation and mitigation of climate change. This synthesis is to be based on technologies tested on-farm, including crop performance, soil response data sets that have been generated. If available, include farmer rankings (sex-disaggregated) and biodiversity impacts of technology.

**Activities:**

1. Document technologies tested at different sites and the number of years they have been in the ground, the crops and rotations during that time, the inputs (whether fertilizers and/or organics – including crop residues, possibly BNF), the time series of soil and crop data collection and the parameters measured.
2. Examine all crop-based activities implemented and document crop biomass (legumes and cereals) for different agro-potential zones in ESA and work with scenarios for residue management
   1. All crop residues are removed from fields, save for roots (as is often the case), and
   2. Proportion of crop residues deliberately retained in fields.
3. Land management strategies that reduce erosion - tied ridges, contours on steep landscapes, etc, and evidence from trials and surveys
4. Conservation agriculture as a specific intervention –
5. Radar charts to better understand performance across domains. SOC stocks remain a grey area. The capacity of SI technologies for SOC sequestration has already been identified as a research gap. We will take advantage of on-farm trials that are at least 10 years old to generate empirical evidence on this subject. This is described as Part 2 below.

**Deliverables**

1. Report on SOC sequestration potential for different cropping systems and climate change adaptation, and research gaps in line with the SIAF

Part 2: Research activity: Quantifying the SOC gains -soil carbon sequestration in long term on-farm trials in central Malawi and southern Malawi

Soil functions emerge from the complex interaction of physical, biological, and chemical processes. In agroecosystems, management practices and pedoclimatic conditions modulate soil processes. Management can change soil architecture and the hydraulic functions, shift biological diversity and modify the carbon sequestration potential. Diversification of cropping systems with legumes has the potential to improve yield stability and soil fertility through both cereal residues and high-quality legume residues (Chimonyo et al., 2019[[66]](#footnote-67)). Where deep-rooted crops, such as pigeonpea are included, the potential for significant SOC sequestration is enhanced as root turnover at soil depth results in SOC that is not prone to erosion losses.

SOC sequestration is a very slow process; as a result short-term field experiments (< 5 years) barely result in discernible cropping systems' effects on SOC stocks (refs here). On-farm long-term trials are very rare in Africa. As a result, the extent to which SOC sequestration occurs as influenced by cropping systems and climatic conditions has not been extensively studied in long-term on-farm trials in Africa. In November 2012, the Africa RISING project established on-farm trials in central Malawi across three agro-ecologies. These trials have been maintained since then, providing a rare ‘decade-long’ multi-locational trials that have a track record of good management.

Soils will be sampled from three-decade-long trials, located in low, medium, and high agroe-cological zones in central Malawi (*Golomoti, Kandeu, and Linthipe*). The team will assess changes in key soil properties that define soil multi-functionality by measuring soil organic carbon sequestration and understanding the different SOC pools.

**Objectives**

1. To establish the SOC saturation deficit after 5 legume –maize rotation cycles over a decade.
2. Profile the SOC pools as a function of long-term management
3. Provide critical empirical evidence for use in the SIAF framework on SOC gains for long-term interventions on smallholder farms
4. To establish relationship between SOC stocks/ pools with annualized yields of cereals and legumes for 10 years

**Experimental design and approach:**

Each of the three sites has the following treatments, replicated 3 times:

**MSU- ISFM**

1. Continuous unfertilized maize
2. Continuous NPK fertilized maize
3. Groundnut-Maize rotation [by April 2022 will have completed 5 rotation cycles = 5 years of groundnut and 5 years of maize]
4. Soybean-maize ration [by April 2022 will have completed 5 rotation cycles = 5 years of soybean and 5 years of maize]
5. Groundnut/pigeonpea intercropping (doubled-up legume technology)
6. Maize/pigeonpea intercropping
7. Nearby natural grassland/mature forest (with little signs of erosion)

**CIMMYT –CA**

Each of the three sites has the following treatments, replicated 4 times:

1. *Farmers check*. Traditional land preparation (ridges) and maize management. Residues may be grazed, removed, burned, or incorporated into the ridges.
2. *Conservation Agriculture – sole maize.* No-tillage, no burning. Previous year’s ridges were retained (but not reformed). Residue retained (mulch).
3. *Conservation Agriculture – maize/legume intercrop (Pigeonpea or Cowpea)*. No-tillage, no burning. Previous year’s ridges were retained (but not reformed). Residue retained (mulch).
4. *Rotation:*

*Divide plots into* half (500m²) and continue a rotation of maize with Pigeon peas and/or ground nuts on each plot.

Section A: Maize

Section B: Groundnuts/pigeon pea alley cropping

1. *Nearby natural grassland/mature forest (with little signs of erosion)*

**Soil sampling and processing**

1. At each of the sites, soil samples will be taken for 8 soil layers: 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105, and 105-120 cm using soil augers. A composite sample of 4 cores will be taken from each plot. Soils from different replicates will be kept separate. Replicated soil samples from the 8 depths will also be taken from the uncultivated area nearby (treatments 7 and 5, for MSU and CIMMYT, respectively)
2. At each trial site, 2 pits will be dug to at least 120 cm depth. Soils for bulk density will be sampled in the middle section of each of these depths: 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105, and 105-120 cm. Respective bulk densities will be applied for each layer for SOC stocks determination

**Deliverables**

1. SOC stocks and pools quantified for different cropping systems
2. The SIAF environmental domain completed with carefully measured empirical data on SOC for different technologies
3. Manuscript, possibly for one of the ‘Nature’ journals

**B: Farmer access to seeds and technologies: Innovations in enabling farmers to take up practices and access quality seeds**

Crop production in Malawi and Tanzania is mainly dominated by smallholder farmers who face several production, marketing, financing, and policy challenges such as poor access to inputs, lack of seeds of improved high yielding and adapted varieties, credit services, and reliable input markets among other things. Seed is the most important input related to crop production. The adoption of improved quality seeds remains low in these countries. The lack of access to and adoption of quality seeds limits smallholder farmers’ production and productivity (Akpo et al., 2021[[67]](#footnote-68)) thereby leading to increased food insecurity and poverty. In response to these problems, the Africa RISING project has developed, evaluated, and promoted improved cereal, legume, and vegetable seeds. The project focus was on making high-quality cereal, legume, and vegetable seeds accessible to smallholder farmers. In a bid to increase improved quality seed supply, access, and affordability, the project tested various seed supply models from informal to formal seed systems. While these project interventions are expected to yield positive outcomes for the direct and indirect beneficiaries, identifying the most sustainable approach and model for farmers to access quality seed is a major challenge. The team will identify the major bottlenecks and research gaps that exist within the cereal, legume, and vegetable seed systems chains that have not yet been addressed during the project and recommend the best approaches to address them towards making these seed value chains more vibrant.

**Objectives**

1. To identify gaps existing in the cereal, legume, and vegetable seed value chains of crops promoted under the Africa RISING project in line with the Sustainable Intensification Assessment Framework (SIAF).
2. To determine the availability, demand, and supply of improved cereal, legumes, and vegetable seeds promoted by the Africa RISING project
3. To examine the scope for the integration of community seed banks, quality declared seeds, and formal seed systems to increase the supply of quality seeds of legumes, cereals, and vegetable open-pollinated varieties
4. To conduct a stakeholders’ analysis with the view of identifying strategic partners who can invest in and deliver quality seeds of legumes, vegetables, and dryland cereals.

**Approach**

To achieve our objectives, a thorough systematic literature review and meta-analysis will be conducted to identify the existing research gaps in the cereal, legume, and vegetable seed systems. This will include reviewing the state-of-the-art recent literature on seed systems as well as previous research and data from the AR project. This will help us to address our objectives while refining them where possible.

Based on the current data sets available for cereals, legumes, and vegetables in Malawi and Tanzania, we will assess the supply and demand for improved seeds in the project sites. This will be important in evaluating the availability, suppliers, and users of improved quality seeds. Similarly, the data from the value chain studies conducted in Malawi and Tanzania, coupled with the data from the scheduled survey on vegetables will be used to identify the key stakeholders in the above-mentioned seed systems. This will be essential in identifying strategic partners who can invest in and deliver quality seeds of legumes, vegetables, and dryland cereals. Finally, to investigate whether there is a scope for the integration of community seed banks, quality declared seed and formal seed systems, data will be collected through a targeted survey on the seed policy landscape in Malawi and Tanzania.

**Deliverables**

1. Report on the seed systems research gaps in line with the SIAF

2. Manuscript

**Team C rationale**: Linking human, plant, and soil nutrition: Field crop and vegetable system technologies that enhance the nutrition of humans, plants, and soils.

The primary focus of crop breeding strategies has been to increase the yield of calorie-rich food crops. Such crop cultivars contain calorie-rich macronutrients such as fat, protein, and carbohydrate but not necessarily adequate vitamins, minerals, and other phytochemicals to meet human nutritional needs. There is a pressing need for redesigning agriculture to achieve sustainability and for utilizing modern breeding to add nutritional value to crops for the benefit of the diverse human population.

**Objective**: This group is focusing on the connections between soil nutrient levels, crop nutrient content, food nutrient quality, and human nutrition outcomes. The work will synthesize research lessons from Africa RISING East Africa, especially in Malawi and Tanzania, at each phase (soil, plant, human). That synthesis will be combined with a literature review, especially focusing on iron, zinc, and selenium.

**Deliverable:** The final product will be a report that can be turned into a journal article manuscript with a focus on how future research in East Africa on soil–plant–human nutrition could best be designed to contribute to sustainable development.

**D: Enhancing biodiversity, agroforestry, shrubby legume, and crop diversity**

Part 1. Synthesis: Africa RISING implemented research activities in ESA and tested different crop varieties, crop combinations, and applied crop sequences that include legumes and cereals. The generated and recycled biomass is expected to moderate the soil-crop environment and functioning. Biodiversity is usually explored at three levels - genetic diversity, species diversity, and ecosystem diversity. We aim to understand how Africa RISING has contributed to the biodiversity of farming systems in the ESA region.

**Activities:**

1. Document technologies tested at different sites and how they impacted cropping diversity on smallholder farms (agroforestry, grain legumes, CA systems)
2. Distill data on crop diversity indices from farm surveys and relate them with farms sizes (e.g. data from Case Studies in Malawi and Panel surveys
3. Understand the market share of newly introduced crop varieties (e.g. bio-fortified common bean varieties, pigeon pea, etc.)
4. Soil microbiology is critical to soil health – however, in 10 years, little effort was directed to studying the impact of SI technologies on soil microbial diversity. This is a research gap that will be addressed in Part 2.

**Deliverable:** The final product will be a report on the contribution of the Africa RISING approach to enhancing biodiversity in the ESA region.

Part 2. Research activity: In-depth investigations on soil microbial species diversity under long-term ISFM and CA interventions in Central Malawi

Soil biodiversity is the variety of life that exists within the soil, including bacteria, fungi, earthworms, and termites. The extent of the diversity of microorganisms in soils is critical to the maintenance of soil health and quality since they are involved in important soil functions. The rhizosphere is of central importance not only for plant nutrition, health, and quality but also for microorganism-driven carbon sequestration, ecosystem functioning, and nutrient cycling. Long-term soil management practices affect soil health. Soil bacteria and fungi play pivotal roles in various biogeochemical cycles and are responsible for the cycling of organic compounds. Soil microorganisms also influence above-ground ecosystems by contributing to plant nutrition (Timonen et al., 1996[[68]](#footnote-69)), plant health (Filion et al., 2002[[69]](#footnote-70)), and soil structure (Gupta, 2011[[70]](#footnote-71)).

The long-term SI experiments in central Malawi offer an excellent case for profiling soil microbial communities after 10 years of known cropping practices that include legume cereal rotations, intercropping, and mineral fertilizer use (see details outlined by **Team A**).

This team will collaborate with Team A, and analyze soils from three long-term on-farm field trials on ISFM in Linthipe, Kandeu, and Golomoti. We identified soil microbiology studies as one of the barely studied subjects in biodiversity in Africa RISING.

Objectives

1. To profile microbial populations from soils collected from treatments outlined by Team A
2. To determine the genetic diversity of bacteria and fungi in the soils from the different treatments
3. To establish relationships between microbial communities and SOC and SOC pools (from Team A)

**Approach proposed**

Soils to be used for microbial analysis will be collected as outlined for Team A but for only 5 soil depths: 0-15, 15-30, 30-45, 60-75, 90-105 cm. Two sets of soils will be used

1. An air-dried sample, as for SOC studies
2. A sub-sample will be immediately placed on ice in a cooler box, transported to the lab, and stored at below 0℃

Laboratory methods will be based on Kirk et al (2004[[71]](#footnote-72)).

**Deliverables**

1. A catalog of fungi and bacteria found in the soils from different treatments
2. A draft manuscript for publication

**E: SIAF expansion to be more participatory and responsive to social sciences, especially gender-aware**

The SIAF booklet ([Guide for the sustainable intensification assessment framework](https://scholar.google.com/scholar?oi=bibs&cluster=15013205675477447741&btnI=1&hl=en)[[72]](#footnote-73)) and accompanying methods working paper, require expansion in terms of developing and writing up exercises and indicators that support sustainable agriculture development being conducted through a human-centered, participatory action approach, one that is gender-aware.

**Approach proposed:**

* Development of a draft write-up to be integrated into the SIAF booklet (June and July 2022)
* Virtual workshop to generate feedback and discussion on draft (July 2022)
* Finalization of the draft for inclusion in the SIAF booklet (August 2022)

In a first step, a draft write-up ofexercises and indicators will be produced to be integrated into the SIAF booklet and accompanying methods and indicators booklet.

Through a virtual workshop (step two) feedback will be generated from Africa RISING scientists. This will support honing and finalizing the product.

**Deliverables**

1. Draft write-up
2. Virtual workshop
3. An updated SIAF will be prepared to be published in a format that will be widely accessible and provides guidance for multidisciplinary teams engaged in sustainable agriculture development, both to plan and synthesize research in a stakeholder-engaged and iterative manner, to support the development of new knowledge, farmer-adoptable innovations, and local adaptive capacity.

1. Smith, A., Snapp, S., Dimes, J., Gwenambira, C., and Chikowo R. 2016. Doubled-up legume rotations improve soil fertility and maintain productivity under variable conditions in maize-based cropping systems in Malawi. Agricultural Systems. 145: 139–149. [↑](#footnote-ref-2)
2. Snapp, S.S., P. Grabowski, R. Chikowo, A. Smith, E. Anders, D. Sirrine, V. Chimonyo and M. Bekunda. 2018. Maize yield and profitability tradeoffs with social, human and environmental performance: Is sustainable intensification feasible? Agricultural Systems 162: 77-88. [↑](#footnote-ref-3)
3. Chimonyo VGP, Snapp S, Chikowo R 2019. Grain Legumes Increase Yield Stability in Maize Based Cropping Systems. Crop Science 59: 1222–1235. doi:10.2135/cropsci2018.09.0532. [↑](#footnote-ref-4)
4. Gwenambira-Mwika C, S Snapp S, Chikowo R 2021. [Broadening farmer options through legume rotational and intercrop diversity in maize-based cropping systems of central Malawi.](file:///C:\Users\USER\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\201DIH0H\Broadening%20farmer%20options%20through%20legume%20rotational%20and%20intercrop%20diversity%20in%20maize-based%20cropping%20systems%20of%20central%20Malawi) Field Crops Research 270, https://doi.org/10.1016/j.fcr.2 [↑](#footnote-ref-5)
5. John I, S Snapp, A Nord, V Chimonyo, C Gwenambira, R Chikowo 2021. [Marginal more than mesic sites benefit from groundnut diversification of maize: Increased yield, protein, stability, and profits](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=92IYh5IAAAAJ&cstart=20&pagesize=80&citation_for_view=92IYh5IAAAAJ:5Ul4iDaHHb8C). Agriculture, Ecosystems & Environment 320, 107585 [↑](#footnote-ref-6)
6. Smith, A., Snapp, S., Dimes, J., Gwenambira, C., and Chikowo R. 2016. Doubled-up legume rotations improve soil fertility and maintain productivity under variable conditions in maize-based cropping systems in Malawi. Agricultural Systems. 145: 139–149 [↑](#footnote-ref-7)
7. Snapp, S.S., P. Grabowski, R. Chikowo, A. Smith, E. Anders, D. Sirrine, V. Chimonyo and M. Bekunda. 2018. Maize yield and profitability tradeoffs with social, human and environmental performance: Is sustainable intensification feasible? Agricultural Systems 162: 77-88 [↑](#footnote-ref-8)
8. Chimonyo VGP, Snapp S, Chikowo R 2019. Grain Legumes Increase Yield Stability in Maize Based Cropping Systems. Crop Science 59: 1222–1235. doi:10.2135/cropsci2018.09.0532 [↑](#footnote-ref-9)
9. Kimaro et al. 2019. Understanding the Multidimensionality of Climate-Smartness: Examples from Agroforestry in Tanzania. <https://link.springer.com/chapter/10.1007/978-3-319-92798-5_13> [↑](#footnote-ref-10)
10. Kizito et al. 2022. Soil and water conservation for climate-resilient agriculture. Handbook Chapter, In press. [↑](#footnote-ref-11)
11. Nassoro et al. 2015. Evaluation of nutritive value of browse tree fodder species in Semi-arid Districts of Tanzania. <http://world-food.net/category/journals/2015/issue-34-2015/> [↑](#footnote-ref-12)
12. Hafner et al. 2020. Efficiency of Three-Stone Fire and Improved Cooking Stoves using on-farm and off-farm fuels in semi-arid Tanzania. Energy for Sustainable Development 59: 199-207. <https://doi.org/10.1016/j.esd.2020.10.012> [↑](#footnote-ref-13)
13. Renwick et al. 2020. Maize-pigeonpea intercropping outperforms monocultures under drought. Front. Sustain. Food Syst. 4:562663. <https://www.frontiersin.org/articles/10.3389/fsufs.2020.562663/full> [↑](#footnote-ref-14)
14. Swamila et al. 2020. Gliricidia Agroforestry Technology Adoption Potential in Selected Dryland Areas of Dodoma Region, Tanzania. *Agriculture*, <https://www.mdpi.com/2077-0472/10/7/306/pdf> [↑](#footnote-ref-15)
15. Bruck, S.R. and Kuusela, O.P. 2021. How health and market access associate with agroforestry adoption decisions: evidence from Tabora, Tanzania. Agroforest Syst. 95, 1073–1086. <https://doi.org/10.1007/s10457-021-00629-3> [↑](#footnote-ref-16)
16. Kimaro et al. 2016. Is conservation agriculture ‘climate-smart’ for maize farmers in the highlands of Tanzania? Nutr Cycl Agroecosyst 105: 217–228. <http://link.springer.com/article/10.1007/s10705-015-9711-8> [↑](#footnote-ref-17)
17. Liingilie. 2019. Effects of Grilicidia sepium intercropping, rainwater harvesting and planting times on maize performance in Kongwa District, Tanzania. M.Sc. Dissertation, SUA, <http://www.suaire.sua.ac.tz/handle/123456789/3426> [↑](#footnote-ref-18)
18. Musumba, M., Grabowski, P., Palm, C. and Snapp, S. 2017. Guide for the sustainable intensification assessment framework. Kansas, USA: Kansas State University. [↑](#footnote-ref-19)
19. Muthoni, Francis K., Zhe Guo, Mateete Bekunda, Haroon Sseguya, Fred Kizito, Frederick Baijukya, and Irmgard Hoeschle-Zeledon. "Sustainable recommendation domains for scaling agricultural technologies in Tanzania. *Land Use Policy* 66 (2017): 34-48. [↑](#footnote-ref-20)
20. Meyer, H., C. Reudenbach, S. Wöllauer, and T. Nauss. 2019. Importance of spatial predictor variable selection in machine learning applications – Moving from data reproduction to spatial prediction. Ecological Modelling **411**:108815. [↑](#footnote-ref-21)
21. Ploton, P., F. Mortier, M. Réjou-Méchain, N. Barbier, N. Picard, V. Rossi, C. Dormann, G. Cornu, G. Viennois, N. Bayol, A. Lyapustin, S. Gourlet-Fleury, and R. Pélissier. 2020. Spatial validation reveals poor predictive performance of large-scale ecological mapping models. Nature Communications **11**:4540. [↑](#footnote-ref-22)
22. LeCun, Y., Bengio, Y., Hinton, G. (2015) Deep learning. Nature 521, 436-444. [↑](#footnote-ref-23)
23. Cai, Y., et al. (2019) Integrating satellite and climate data to predict wheat yield in Australia using machine learning approaches. Agricultural and Forest Meteorology 274, 144-159. [↑](#footnote-ref-24)
24. Zhang, L., et al., (2021) Integrating satellite-derived climatic and vegetation indices to predict smallholder maize yield using deep learning. Agricultural and Forest Meteorology 311, 108666. [↑](#footnote-ref-25)
25. Haghtalab, N., Moore, N., Ngongondo, C. (2019) Spatio-temporal analysis of rainfall variability and seasonality in Malawi. Regional Environmental Change. [↑](#footnote-ref-26)
26. Reith, et al (2021) Assessment of Land Degradation in Semiarid Tanzania—Using Multiscale Remote Sensing Datasets to Support Sustainable Development Goal 15.3. Remote Sensing 13, 1754. [↑](#footnote-ref-27)
27. Pinzon, E.J. and Tucker, J.C., 2014. A Non-Stationary 1981–2012 AVHRR NDVI3g Time Series. Remote Sensing, 6(8). [↑](#footnote-ref-28)
28. Abatzoglou, J.T., Dobrowski, S.Z., Parks, S.A. and Hegewisch, K.C., 2018. TerraClimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958–2015. Scientific Data, 5: 170191. [↑](#footnote-ref-29)
29. Leroux, L., Bégué, A., Lo Seen, D., Jolivot, A. and Kayitakire, F., 2017. Driving forces of recent vegetation changes in the Sahel: Lessons learned from regional and local level analyses. Remote Sensing of Environment, 191: 38-54. [↑](#footnote-ref-30)
30. Lukmanji, Z., Hertzmark, E., Mlingi, N.A., Assey, V., Ndossi, G. and Fawzi, W., 2008. Tanzania food composition tables. *MUHAS-TFNC, HSPH, Dar Es Salaam Tanzania*. [↑](#footnote-ref-31)
31. Ochieng J, Afari-Sefa V, Karanja D, Kessy R, Rajendran S, Samali S. How promoting consumption of traditional African vegetables affects household nutrition security in Tanzania. Renew Agric Food Syst. 2018;33(2):105-115. doi:DOI: 10.1017/S1742170516000508. [↑](#footnote-ref-32)
32. Fischer, G., Wittich, S., Malima, G., Sikumba, G., Lukuyu, B., Ngunga, D., & Rugalabam, J. (2018) Gender and mechanization: Exploring the sustainability of mechanized forage chopping in Tanzania. Journal of Rural Studies, 64: 112-122. <https://doi.org/10.1016/j.jrurstud.2018.09.012> [↑](#footnote-ref-33)
33. Kihara, J., Tamene, L.D., Massawe, P. *et al.* Agronomic survey to assess crop yield, controlling factors and management implications: a case-study of Babati in northern Tanzania. *Nutr Cycl Agroecosys* **102,** 5–16 (2015). https://doi.org/10.1007/s10705-014-9648-3 [↑](#footnote-ref-34)
34. See previous footnote [↑](#footnote-ref-35)
35. 2014. Agronomic survey to assess crop yield, controlling factors and management implications: a case-study of Babati in northern Tanzania. Nutrient Cycling in Agroecosystems. DOI: 10.1007/s10705-014-9648-3 [↑](#footnote-ref-36)
36. Gollin, D., Hansen, C.W., Wingender, A.M., 2021. Two blades of grass: The impact of the green revolution. J. Polit. Econ https://doi.org/10.1086/714444 [↑](#footnote-ref-37)
37. Ogutu, S.O., Gödecke, T., Qaim, M., 2019. Agricultural Commercialisation and Nutrition in Smallholder Farm Households. J. Agric. Econ. 71, 534–555 [↑](#footnote-ref-38)
38. Carletto, C., Corral, P., Guelfi, A., 2017. Agricultural commercialization and nutrition revisited: Empirical evidence from three African countries. Food Policy 67, 106–118 [↑](#footnote-ref-39)
39. Carletto, C., Corral, P., Guelfi, A., 2017. Agricultural commercialization and nutrition revisited : Empirical evidence from three African countries. Food Policy 67, 106–118. https://doi.org/10.1016/j.foodpol.2016.09.020 [↑](#footnote-ref-40)
40. Wooldridge, J.M., 2010. Econometric Analysis of Cross Section and Panel Data. MIT Press. [↑](#footnote-ref-41)
41. Burke, W.J., Snapp, S.S., Jayne, T.S., 2020. An in-depth examination of maize yield response to fertilizer in Central Malawi reveals low profits and too many weeds. Agric. Econ. 51, 923–940 [↑](#footnote-ref-42)
42. Marsh, D.R., Schroeder, D.G., Dearden, K.A., Sternin, J., Sternin, M., 2004. The power of positive deviance. BMJ: British Medical Journal 329, 1177. [↑](#footnote-ref-43)
43. Pant, L.P., Odame, H.H., 2009. The promise of positive deviants: bridging divides between scientific research and local practices in smallholder agriculture. Knowledge Management for Development Journal 5, 160-172. [↑](#footnote-ref-44)
44. Bradley, E.H., Curry, L.A., Ramanadhan, S., Rowe, L., Nembhard, I.M., Krumholz, H.M., 2009. Research in action: using positive deviance to improve quality of health care. Implementation Science 4, 25. [↑](#footnote-ref-45)
45. Groot, J.C., Oomen, G.J., Rossing, W.A., 2012. Multi-objective optimization and design of farming systems. Agricultural Systems 110, 63-77. [↑](#footnote-ref-46)
46. Groot, J.C., Jellema, A., Rossing, W.A., 2010. Designing a hedgerow network in a multifunctional agricultural landscape: balancing trade-offs among ecological quality, landscape character and implementation costs. European Journal of Agronomy 32, 112-119. [↑](#footnote-ref-47)
47. Das, I., 1999. A preference ordering among various Pareto optimal alternatives. Structural optimization 18, 30-35. [↑](#footnote-ref-48)
48. Groot, J.C., Oomen, G.J., Rossing, W.A., 2012. Multi-objective optimization and design of farming systems. Agricultural Systems 110, 63-77. [↑](#footnote-ref-49)
49. Modernel, P., Dogliotti, S., Alvarez, S., Corbeels, M., Picasso, V., Tittonell, P., Rossing, W.A., 2018. Identification of beef production farms in the Pampas and Campos area that stand out in economic and environmental performance. Ecological Indicators 89, 755-770. [↑](#footnote-ref-50)
50. Arndt, C., Pauw, K., & Thurlow, J. (2016). The economy-wide impacts and risks of Malawi’s farm input subsidy [↑](#footnote-ref-51)
51. Mponela, P. (2020). *Options for Sustainable Agricultural Intensification in Maize Mixed Farming Systems: Explorative ex-ante assessment using Multi-Agent System Simulation*. University of Bonn [↑](#footnote-ref-52)
52. Messina, J. P., Peter, B. G., & Snapp, S. S. (2017). Re-evaluating the Malawian Farm Input Subsidy Programme. *Nature Plants*, *3*(4), 17044. https://doi.org/10.1038/nplants.2017.13 [↑](#footnote-ref-53)
53. Francis K. Muthoni, Zhe Guo, Mateete Bekunda, Haroon Sseguya, Fred Kizito, Fredrick Baijukya, Irmgard, Hoeschle-Zeledon, 2017. Sustainable recommendation domains for scaling agricultural technologies in Tanzania. Land use policy 66: 34-48. [↑](#footnote-ref-54)
54. See Wang, et al., (2019) for details about the surveys, including the sampling procedure [↑](#footnote-ref-55)
55. Asfaw, S., Mithöfer, D., Waibel, H., 2009. Investment in compliance with GlobalGAP standards: Does it pay off for small-scale producers in Kenya? Q. J. Int. Agric. 48, 337–362 [↑](#footnote-ref-56)
56. Kleemann, L., Abdulai, A., Buss, M., 2014. Certification and access to export markets: Adoption and return on investment of organic-certified pineapple farming in Ghana. World Dev. 64, 79–92 [↑](#footnote-ref-57)
57. Udry, C., Anagol, S., Field, E., Leonard, K., Weil, D., 2006. The return to capital in Ghana. Am. Econ. Rev. 96, 388–393 [↑](#footnote-ref-58)
58. Kassie, M. et al. (2015) ‘Production Risks and Food Security under Alternative Technology Choices in Malawi: Application of a Multinomial Endogenous Switching Regression’, Journal of Agricultural Economics, p. n/a-n/a. doi: 10.1111/1477-9552.12099. [↑](#footnote-ref-59)
59. Kotu, B. H. et al. (2017) ‘Adoption and impacts of sustainable intensification practices in Ghana’, International Journal of Agricultural Sustainability. Taylor & Francis, 15(5), pp. 539–554. doi: 10.1080/14735903.2017.1369619 [↑](#footnote-ref-60)
60. Manda, J. et al. (2015) ‘Adoption and Impacts of Sustainable Agricultural Practices on Maize Yields and Incomes: Evidence from Rural Zambia’, Journal of Agricultural Economics, 67(1), pp. 130–153. doi: 10.1111/1477-9552.12127. [↑](#footnote-ref-61)
61. Bentley, J. W., Danielsen, S., Phiri, N., Tegha, Y. C., Nyalugwe, N., Neves, E., ... & Sharma, D. R. (2018). Farmer responses to technical advice offered at plant clinics in Malawi, Costa Rica and Nepal. *International journal of agricultural sustainability*, *16*(2), 187-200. [↑](#footnote-ref-62)
62. United States Agency for international development (USAID).( 2015)Literature review: scaling agricultural technologies and innovation diffusion. <https://pdf.usaid.gov/pdf_docs/pa00kfqg.pdf> [↑](#footnote-ref-63)
63. Munthali, W. and Okori, P. 2018. Community seed banks in Malawi: An informal approach for seed delivery. Ibadan, Nigeria: IITA. <https://cgspace.cgiar.org/bitstream/handle/10568/96202/malawi_model.pdf?sequence=1&isAllowed=y> [↑](#footnote-ref-64)
64. Anonymous, 2015. The cost of the gender gap in agricultural productivity in Malawi, Tanzania and Uganda. (UN Women, UNDP-UN Environment Poverty-Environment Initiative and the World Bank, 2015. [↑](#footnote-ref-65)
65. Abakerli, S. 2012. Sectoral Perspectives on Gender and Social Inclusion. Agriculture. Gender and Social Exclusion Assessment 2011 Sectoral Series: Monograph 1. A co-publication of the Asian Development Bank, Department for International Development, UK, and The World Bank. [↑](#footnote-ref-66)
66. Chimonyo VGP, Snapp S, Chikowo R 2019. Grain Legumes Increase Yield Stability in Maize Based Cropping Systems. Crop Science 59: 1222–1235. doi:10.2135/cropsci2018.09.0532 [↑](#footnote-ref-67)
67. ## Akpo Essegbemon , Ojiewo Chris O. , Kapran Issoufou , Omoigui Lucky O. , Diama Agathe , Varshney Rajeev K. 2021. Enhancing Smallholder Farmers' Access to Seed of Improved Legume Varieties Through Multi-stakeholder Platforms. Learning from the TLIII project Experiences in sub-Saharan Africa and South Asia. Springer

    [↑](#footnote-ref-68)
68. Timonen Sari,. Finlay Roger D, Olsson Stefan, Söderström Bengt 1996. Dynamics of phosphorus translocation in intact ectomycorrhizal systems: non-destructive monitoring using a *β*-scanner, *FEMS Microbiology Ecology*, Volume 19, 171–180, <https://doi.org/10.1111/j.1574-6941.1996.tb00210.x> [↑](#footnote-ref-69)
69. Filion [M.](https://nph.onlinelibrary.wiley.com/action/doSearch?ContribAuthorRaw=FILION%2C+M) , St-Arnaud [M.](https://nph.onlinelibrary.wiley.com/action/doSearch?ContribAuthorRaw=ST-ARNAUD%2C+M) , Fortin [J. A.](https://nph.onlinelibrary.wiley.com/action/doSearch?ContribAuthorRaw=FORTIN%2C+J+A)  2002. Direct interaction between the arbuscular mycorrhizal fungus Glomus intraradices and different rhizosphere microorganisms. New Phytologist 141.525-533. <https://doi.org/10.1046/j.1469-8137.1999.00366.x> [↑](#footnote-ref-70)
70. Gupta V. (2011) Microbes and Soil Structure. In: Gliński J., Horabik J., Lipiec J. (eds) Encyclopedia of Agrophysics. Encyclopedia of Earth Sciences Series. Springer, Dordrecht. https://doi.org/10.1007/978-90-481-3585-1\_91 [↑](#footnote-ref-71)
71. Kirk [Jennifer L,](https://www.sciencedirect.com/science/article/abs/pii/S0167701204000983#!) Beaudette [Lee A,](https://www.sciencedirect.com/science/article/abs/pii/S0167701204000983#!)  Hart [Miranda,](https://www.sciencedirect.com/science/article/abs/pii/S0167701204000983#!)  Moutoglis [Peter,](https://www.sciencedirect.com/science/article/abs/pii/S0167701204000983#!) Klironomos [John N,](https://www.sciencedirect.com/science/article/abs/pii/S0167701204000983#!)  Lee [Hung,](https://www.sciencedirect.com/science/article/abs/pii/S0167701204000983#!)  Trevors [Jack T](https://www.sciencedirect.com/science/article/abs/pii/S0167701204000983#!) . Methods of studying soil microbial diversity. [Journal of Microbiological Methods](https://www.sciencedirect.com/journal/journal-of-microbiological-methods). 58, 169-188. <https://doi.org/10.1016/j.mimet.2004.04.006> [↑](#footnote-ref-72)
72. M Musumba, P Grabowski, C Palm, S Snapp 2017. [Guide for the sustainable intensification assessment framework](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3906994). Available at SSRN 3906994 [↑](#footnote-ref-73)